
Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

**PRELIMINARY ASSESSMENT AND
SITE INSPECTION FOR
MIDDLESEX SAMPLING PLANT**

Middlesex, New Jersey

June 1989



Bechtel National, Inc.

216215



PRELIMINARY ASSESSMENT
FOR
MIDDLESEX SAMPLING PLANT
MIDDLESEX, NEW JERSEY

JUNE 1989

Prepared for
UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE
Under Contract No. DE-AC05-81OR20722

By
J. H. Wright and D. J. Whiting

Bechtel National, Inc.
Oak Ridge, Tennessee
Bechtel Job No. 14501

TABLE OF CONTENTS

	<u>Page</u>
List of Figures	iv
List of Tables	v
Abbreviations	vi
Acronyms	vii
 1.0 Introduction	 1
2.0 Preliminary Assessment Form	2
3.0 MSP Background	7
3.1 Site History	7
3.2 Owner History	12
4.0 Description of Vicinity Populations	15
5.0 Storage Pile Construction	20
6.0 Summary of Contamination	22
6.1 ORNL Survey	22
6.1.1 Soil Survey	22
6.1.2 Summary of ORNL Survey	22
6.2 Weston Survey	23
6.2.1 Subsurface Soil and Rock Survey	23
6.2.2 Groundwater Survey	31
6.2.3 Summary of Weston Survey	32
6.3 BNI Survey	32
6.3.1 Soil Survey	32
6.3.2 Process Building	35
6.3.3 Boiler House	35
6.3.4 Administration Building	36
6.3.5 Garage	36
6.4 Miscellaneous Environmental Monitoring	37
7.0 Remedial Action	42
8.0 Bibliography	48

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
3-1	Map of the MSP Site	10
3-2	Aerial View of the MSP, Looking South	11
3-3	MSP Site Location	13
4-1	Location of Middlesex, New Jersey	16
4-2	Political Jurisdictions and Major Transportation Routes in the MSP Vicinity	17
4-3	Population Distribution Around MSP and MML	18
4-4	Generalized Land Uses in the Vicinity of MSP and MML	19
6-1	Correlation of Radium Concentration and Counts Per Minute	30
6-2	Borehole Locations at the Former MSP Site	33
6-3	Location of the Mosquito Control Ditch	38
6-4	Radon (Terradex) and External Gamma Radiation Monitoring Locations at MSP	40
7-1	Location of the MSP, MML, and Previously Contaminated Properties	44
7-2	Storage Piles at the MSP Site	45
7-3	Map of the Middlesex Phase II Remedial Action Properties	47

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
3-1	Volumes of Contaminated Soil in the MSP Storage Piles	9
6-1	MSP Remedial Decontamination Project Solid Sample Analysis Results	24
6-2	MSP Groundwater Quality Analysis	27
6-3	Radon-222 Concentrations Measured at MSP Using Terradex Monitors, 1987-1988	39
7-1	Excavated Volume of Contaminated Soil at MSP	43

ABBREVIATIONS

cm	centimeter
cm ²	square centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
ft ²	square foot
g	gram
gal	gallon
ha	hectare
hpd	hours per day
in.	inch
km	kilometer
L	liter
m	meter
m ²	square meter
m ³	cubic meter
mi	mile
mm	millimeter
μR	microroentgen
mrad	millirad
mrad/h	millirad per hour
mrem/yr	millirem per year
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
s	second
yd	yard
yd ²	cubic yard
yr	year

ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
DOE	Department of Energy
EPA	Environmental Protection Agency
MSP	Middlesex Sampling Plant
MED	Manhattan Engineer District
MML	Middlesex Municipal Landfill
NLO	National Lead of Ohio
ORNL	Oak Ridge National Laboratory

1.0 INTRODUCTION

This document presents the findings of the Preliminary Assessment completed for the Middlesex Sampling Plant (MSP) in Middlesex, New Jersey, in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act.

The Preliminary Assessment is the initial evaluation of a hazardous waste site to determine the severity of the threat a site poses to human health and the environment.

Section 2.0 of this report consists of the Preliminary Assessment form required by the U.S. Environmental Protection Agency (EPA). Sections 3.0 through 7.0 contain additional information to supplement the form. A bibliography appears in Section 8.0.

2.0 PRELIMINARY ASSESSMENT FORM

This section consists of the required EPA Preliminary Assessment Form 2070-12, which has been completed for MSP. Supplemental data, such as site ownership and history, descriptions of vicinity populations, storage pile construction, and summaries of contamination surveys, environmental monitoring, and remedial action, are presented in greater detail in Sections 3.0 through 7.0.



POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 0890090012

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common or descriptive name of site)		02 STREET, ROUTE NO. OR SPECIFIC LOCATION IDENTIFIER			
Middlesex Sampling Plant		239 Mountain Avenue			
03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
Middlesex	NJ	08846	Middlesex	23	
09 COORDINATES LATITUDE		LONGITUDE			
-- 40 34 -- N		--- 74 29 -- W			

10 DIRECTIONS TO SITE (Starting from nearest public road)

This site is located at 239 Mountain Avenue in the town of Middlesex, NJ

III. RESPONSIBLE PARTIES

01 OWNER (if known)		02 STREET (Business, mailing, residential)			
Department of Energy, OR Operations		P.O. Box 2001			
03 CITY	04 STATE	05 ZIP CODE	06 TELEPHONE NUMBER		
Oak Ridge	TN	37831	615 576-0948		
07 OPERATOR (if known and different from owner)		08 STREET (Business, mailing, residential)			
(same)					
09 CITY	10 STATE	11 ZIP CODE	12 TELEPHONE NUMBER		
			()		
13 TYPE OF OWNERSHIP (Check one):					
<input type="checkbox"/> A. PRIVATE <input checked="" type="checkbox"/> B. FEDERAL <u>DOE</u> <input type="checkbox"/> C. STATE <input type="checkbox"/> D. COUNTY <input type="checkbox"/> E. MUNICIPAL					
<input type="checkbox"/> F. OTHER: _____ (Specify) <input type="checkbox"/> G. UNKNOWN					

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)	
<input type="checkbox"/> A. RCRA 3001 DATE RECEIVED: _____ MONTH DAY YEAR	<input type="checkbox"/> B. UNCONTROLLED WASTE SITE (CERCLA 103(c)) DATE RECEIVED: _____ MONTH DAY YEAR
<input checked="" type="checkbox"/> C. NONE	

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION		BY (Check all that apply)	
<input type="checkbox"/> YES DATE: _____ MONTH DAY YEAR	<input type="checkbox"/> A. EPA	<input type="checkbox"/> B. EPA CONTRACTOR	<input type="checkbox"/> C. STATE
<input checked="" type="checkbox"/> NO	<input type="checkbox"/> E. LOCAL HEALTH OFFICIAL	<input type="checkbox"/> F. OTHER: _____ (Specify)	<input type="checkbox"/> D. OTHER CONTRACTOR
CONTRACTOR NAME(S): _____			

02 SITE STATUS (Check one)		03 YEARS OF OPERATION	
<input type="checkbox"/> A. ACTIVE	<input checked="" type="checkbox"/> B. INACTIVE	<input type="checkbox"/> C. UNKNOWN	
		BEGINNING YEAR	ENDING YEAR
		1943	1967
		<input type="checkbox"/> UNKNOWN	

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

Radionuclide contaminated soil

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

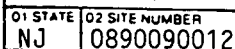
See Section 6.0

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)			
<input type="checkbox"/> A. HIGH (Inspection required promptly)	<input type="checkbox"/> B. MEDIUM (Inspection required)	<input checked="" type="checkbox"/> C. LOW (Inspection on time available basis)	<input type="checkbox"/> D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT		02 OF: Agency or Organization		03 TELEPHONE NUMBER	
B. D. Walker, Acting Director		Department of Energy		615 576-0948	
04 PERSON RESPONSIBLE FOR ASSESSMENT		05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
J. H. Wright		N/A	Bechtel National, Inc.	615 482-1552	11/10/87
				MONTH DAY YEAR	



I HIGHLY VOLATILE
 J EXPLOSIVE
 K REACTIVE
 L INCOMPATIBLE
 M NOT APPLICABLE

EPA FORM 2070-12 (7-81)



POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
NJ	0890090012

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 <input type="checkbox"/> A GROUNDWATER CONTAMINATION 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	--	------------------------------------	----------------------------------

Monitoring indicates no problems

01 <input type="checkbox"/> B SURFACE WATER CONTAMINATION 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	--	------------------------------------	----------------------------------

Monitoring indicates no problems

01 <input checked="" type="checkbox"/> C CONTAMINATION OF AIR 03 POPULATION POTENTIALLY AFFECTED _____	02 <input checked="" type="checkbox"/> OBSERVED (DATE <u>Section 6.0</u>) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	--	------------------------------------	----------------------------------

See Section 4.0 and Section 6.0

01 <input type="checkbox"/> D FIRE/EXPLOSIVE CONDITIONS 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	--	------------------------------------	----------------------------------

01 <input type="checkbox"/> E DIRECT CONTACT 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
--	--	------------------------------------	----------------------------------

01 <input checked="" type="checkbox"/> F CONTAMINATION OF SOIL 03 AREA POTENTIALLY AFFECTED <u>9.6</u> <small>(ACRES)</small>	02 <input checked="" type="checkbox"/> OBSERVED (DATE <u>1986</u>) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	---	------------------------------------	----------------------------------

Nearby properties--have been remediated

01 <input type="checkbox"/> G DRINKING WATER CONTAMINATION 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
--	--	------------------------------------	----------------------------------

01 <input type="checkbox"/> H WORKER EXPOSURE/INJURY 03 WORKERS POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
---	--	------------------------------------	----------------------------------

01 <input type="checkbox"/> I POPULATION EXPOSURE/INJURY 03 POPULATION POTENTIALLY AFFECTED _____	02 <input type="checkbox"/> OBSERVED (DATE _____) 04 NARRATIVE DESCRIPTION _____	POTENTIAL <input type="checkbox"/>	ALLEGED <input type="checkbox"/>
--	--	------------------------------------	----------------------------------



POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
N.J. 0890090012

II. HAZARDOUS CONDITIONS AND INCIDENTS *(Continued)*

01 ☐ J. DAMAGE TO FLORA
04 NARRATIVE DESCRIPTION

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED

01 ☐ K. DAMAGE TO FAUNA
04 NARRATIVE DESCRIPTION *(Include name(s) of species)*

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED

01 ☐ L. CONTAMINATION OF FOOD CHAIN
04 NARRATIVE DESCRIPTION

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED

01 ☐ M. UNSTABLE CONTAINMENT OF WASTES
(Spills, runoff, standing liquids, leaking drums)
03 POPULATION POTENTIALLY AFFECTED _____

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

☒ N. DAMAGE TO OFFSITE PROPERTY
NARRATIVE DESCRIPTION

02 ☐ OBSERVED (DATE 1986) ☐ POTENTIAL ☐ ALLEGED

Previous damage to off site property remediated

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs
04 NARRATIVE DESCRIPTION

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING
04 NARRATIVE DESCRIPTION

02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

III. TOTAL POPULATION POTENTIALLY AFFECTED: See Section 4.0

IV. COMMENTS

SOURCES OF INFORMATION *(Cite specific references e.g. state fees, sample analysis reports)*

See Section 8.0

3.0 MSP BACKGROUND

3.1 SITE HISTORY

The Manhattan Engineer District (MED) established MSP in 1943. The facility was used for the sampling, storage, and shipment of uranium, thorium, and beryllium ores. The uranium operations were conducted under contract with United Lead Company between November 1943 and February 1955 and involved most of the ore and compounds received from the African Metals Company. All ores received at the facility were handled in a similar manner, including thawing (if necessary), drying, crushing, and screening. Samples were taken for assay from collection hoppers beneath screens. The ores were subsequently packaged, weighed, and shipped to processing facilities.

The site received and shipped various research-related and decontamination wastes. Low-level combustible waste was incinerated on the site, and the ashes were placed in drums and sent with the noncombustible waste and scrap for ocean disposal.

During 1951 and 1952, MSP became the transshipment point for uranium bars shipped from the Lake Ontario Ordinance Works to the American Machine and Foundry Company in Brooklyn, New York, where the bars were experimentally machined into slugs. Scrap from this operation was returned to Middlesex to be shipped to a processor for uranium recovery.

Operation of MSP was terminated in 1955 by the Atomic Energy Commission (AEC), successor to MED. Prior to closing in February 1955, the site was also processing beryllium ore for shipment to Brush Beryllium in Luckey, Ohio. The site continued to be used as a thorium materials storage site until AEC operations terminated in September 1967, at which time the site was decontaminated by Isotopes, Inc. On-site structures were decontaminated, and the site was certified for use with no radiological restrictions under criteria in effect at that time.

In 1968, AEC returned the MSP site to the General Services Administration (GSA), which transferred the property to the U.S. Department of the Navy. The site served as a reserve training center for the U.S. Marine Corps from 1969 to 1979. MSP was returned to the U.S. Department of Energy (DOE) in 1980. That same year, DOE initiated remedial action to clean up properties in the vicinity of MSP, with the cleanup continuing into 1981. Approximately 26,600 m³ (35,000 yd³) of contaminated soil from this remedial action was transported to MSP, where an asphalt pad was constructed as a base for an interim storage pile.

Excavation of radioactively contaminated materials from the Middlesex Municipal Landfill (MML) was initiated in 1984, and approximately 11,500 m³ (15,000 yd³) of contaminated soil was transported to MSP for interim storage.

A second storage pile was constructed at MSP in 1984 to accommodate the materials excavated from MML. The storage pile was extended again in 1986, and the stockpile height was increased to accept the material excavated from the MML during that year. The piles were enclosed with concrete curbing to prevent migration of the stored materials. Synthetic geomembrane fabric was attached to the curbing site to cover the stored materials when remedial action was not in progress. Table 3-1 shows the total volume of contaminated materials presently stored at MSP, including the source of the materials and when they were emplaced.

The MSP site occupies 9.6 acres (3.9 ha), 8 of which were paved with asphalt to provide a drum-storage area. As shown in Figure 3-1, the four buildings that remain on the site, which is surrounded by a 2.1-m (7-ft) chain-link fence, include the following: administration building, process building, garage, and boiler house. MSP is currently used for interim storage of contaminated soil excavated from vicinity properties, including MML. Figure 3-2 provides an aerial photograph of the site. At the completion of the 1986 remedial actions, approximately 50,600 m³ (66,200 yd³) of contaminated soil was stored at MSP. The design of the interim

TABLE 3-1
VOLUMES OF CONTAMINATED SOIL
IN THE MSP STORAGE PILES

Date and Source	Volume	
	(m ³)	(yd ³)
1980 (Phase I) MSP Cleanup	7,203	9,421
1981 (Phase II) MSP Cleanup	19,681	25,742
1984 MML Cleanup (Separate Storage Pile)	11,468	15,000
1986 MML Cleanup (Extended Second Storage Pad)	<u>12,233</u>	<u>16,000</u>
TOTAL	50,585	66,163

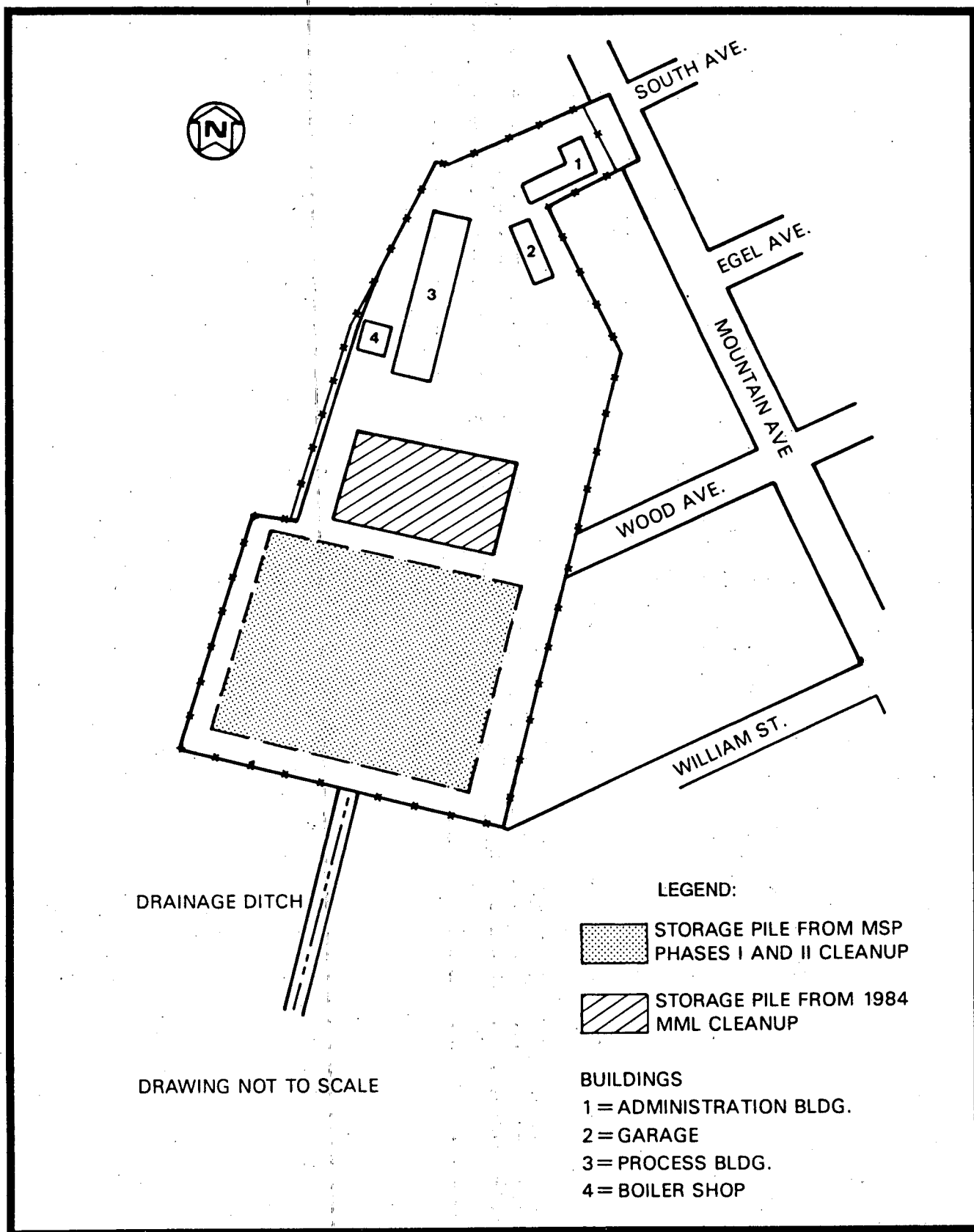


FIGURE 3-1 MAP OF THE MSP SITE

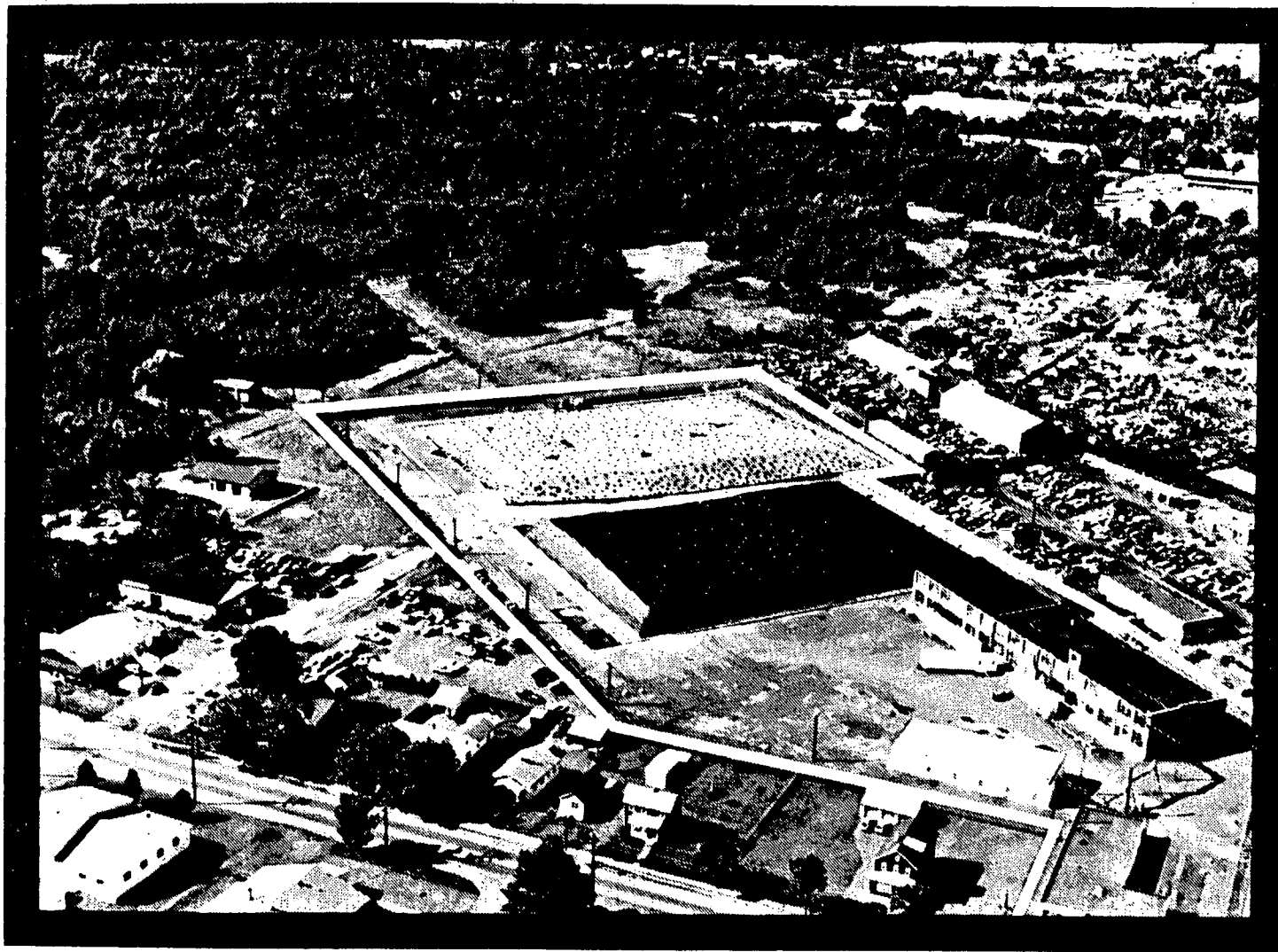


FIGURE 3-2 AERIAL VIEW OF MSP

storage pile at the site includes a leachate collection system to preclude the uncontrolled release of contaminants.

The east side of the facility borders on fields and garden areas. The west side borders an industrial site. The property to the south consists of marshy land and fields. The main entrance to the facility (Mountain Avenue) is on the north side. The north side also borders the Lehigh Valley Railroad right-of-way property. Figure 3-3 shows the location of the site in Middlesex.

3.2 OWNER HISTORY

At the request of MED, the North Atlantic Division Engineers leased the first portion of the MSP property from American Marietta Company on November 1, 1943. Supplements to the lease were issued on May 15, 1945, and June 27, 1945, to include additional properties. Another lease was executed with private owners of nearby property to expand the storage area of the site and obtain easements. Procedures for government purchase of the property were initiated on March 8, 1946, and procurement was authorized by the Secretary of War on June 20, 1946. Because the owners would not sell willingly at the appraised value of the property, a Petition in Condemnation and a Declaration of Taking were filed on September 12, 1947, and the leases were thereby cancelled. A Judgment on Stipulation, filed on June 15, 1957, gave AEC title to the property for an acceptable price. Easement agreements for drainage across the properties south of the site were also obtained by AEC.

The site was operated by United Lead Company for AEC until the site closed in 1955. Lucius Pitkin conducted the thorium storage operations on the site after 1955.

On February 22, 1968, AEC officially reported the property as excess real property. On January 3, 1969, GSA transferred the property to the U.S. Department of the Navy, U.S. Marine Corps. The U.S. Marine Corps used the property for the 6th Motor Transport Battalion Reserve

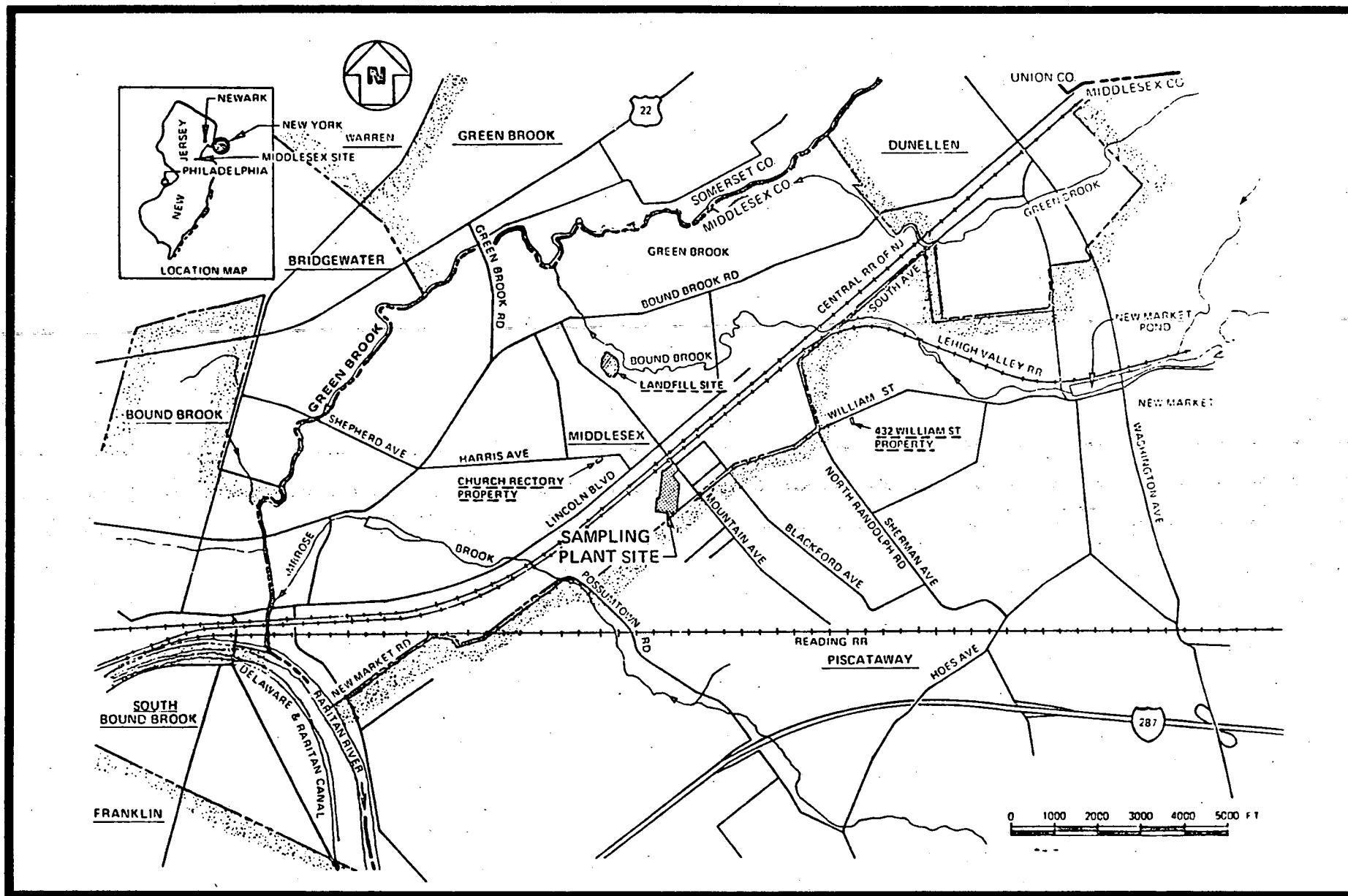


FIGURE 3-3 MSP SITE LOCATION

Training. Through an agreement established in 1980, DOE agreed to be custodian of the site and contracted with National Lead of Ohio, Inc. (NLO) to maintain it. In 1981, Bechtel National, Inc. (BNI), replaced NLO as the project management contractor for remedial actions.

4.0 DESCRIPTION OF VICINITY POPULATIONS

Middlesex, New Jersey, is located in an urban area about 35 km (22 mi) southwest of downtown Manhattan (New York City), 24 km (15 mi) southwest of Newark, New Jersey, and 48 km (30 mi) northeast of Trenton, New Jersey (Figure 4-1).

Three counties and numerous smaller political subdivisions are within an 8-km (5-mi) radius of the nearby MML. Political jurisdictions and major transportation routes are shown in Figure 4-2.

The residential population within 0.8, 1.2, and 1.6 km (0.5, 0.75, and 1 mi) of the MML site was estimated from a count of residences within each sector. The population distribution is shown in Figure 4-3. The residential population within 1.6 km (1 mi) of the MML site boundary is estimated at 10,400 people living in approximately 2,900 dwellings.

Approximately 6,000 people are employed at firms located within 1.6 km (1 mi) of the nearby MML site. Most of the employees are working in the industrial and commercial zones along Lincoln Boulevard, South Avenue, Bound Brook Road, and State Route 22. Generalized land uses in the vicinity of MSP are shown in Figure 4-4.

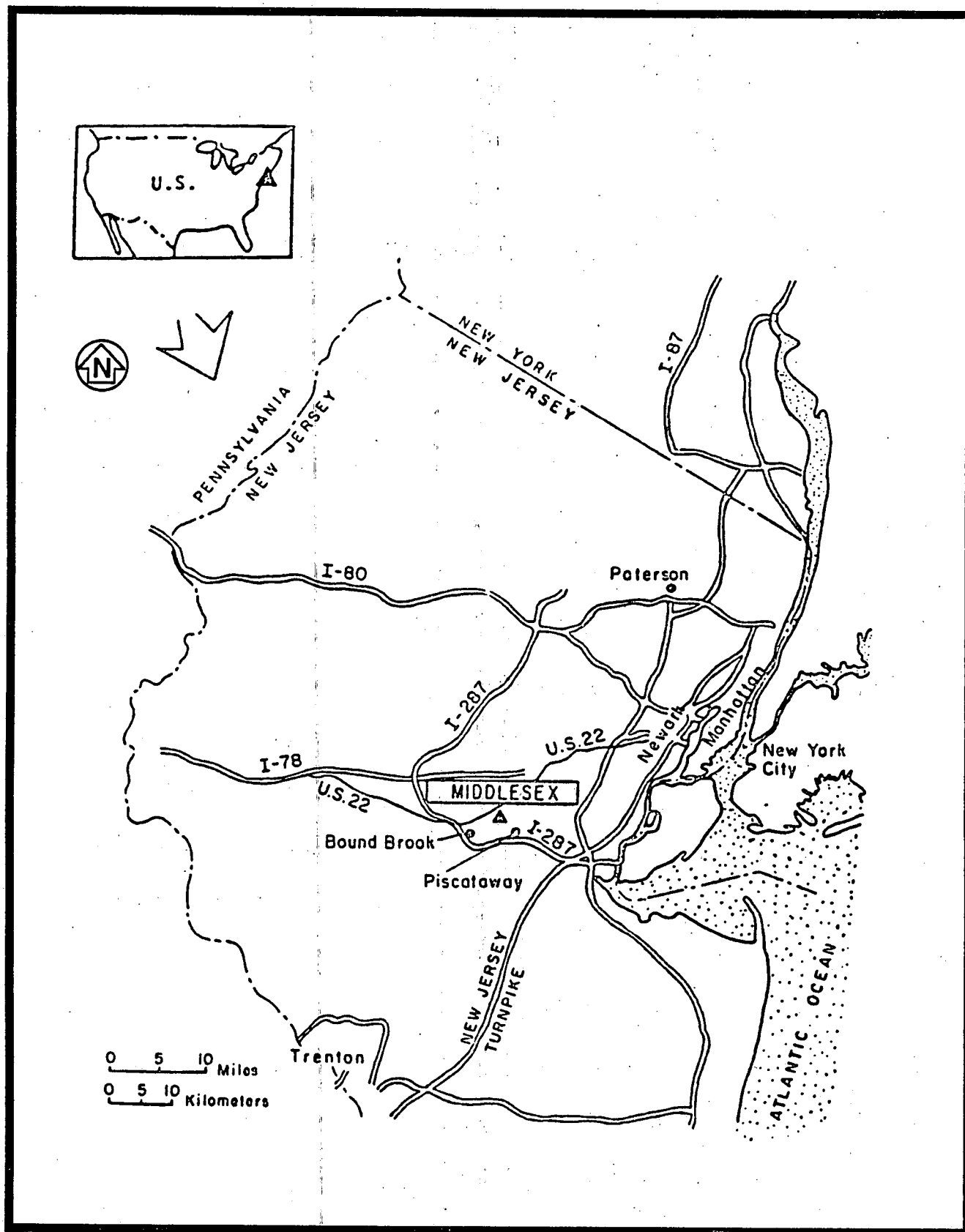


FIGURE 4-1 LOCATION OF MIDDLESEX, NEW JERSEY

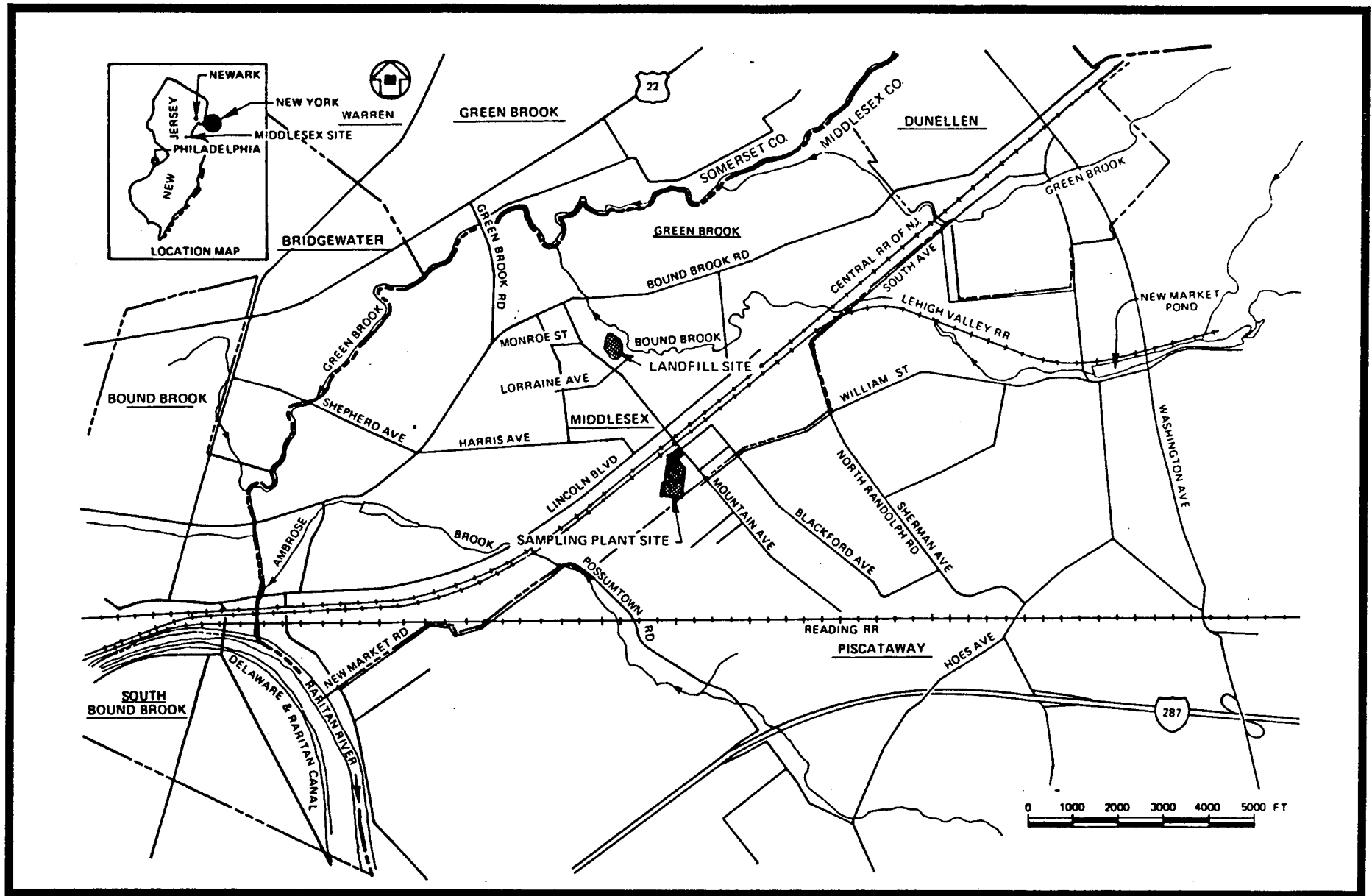
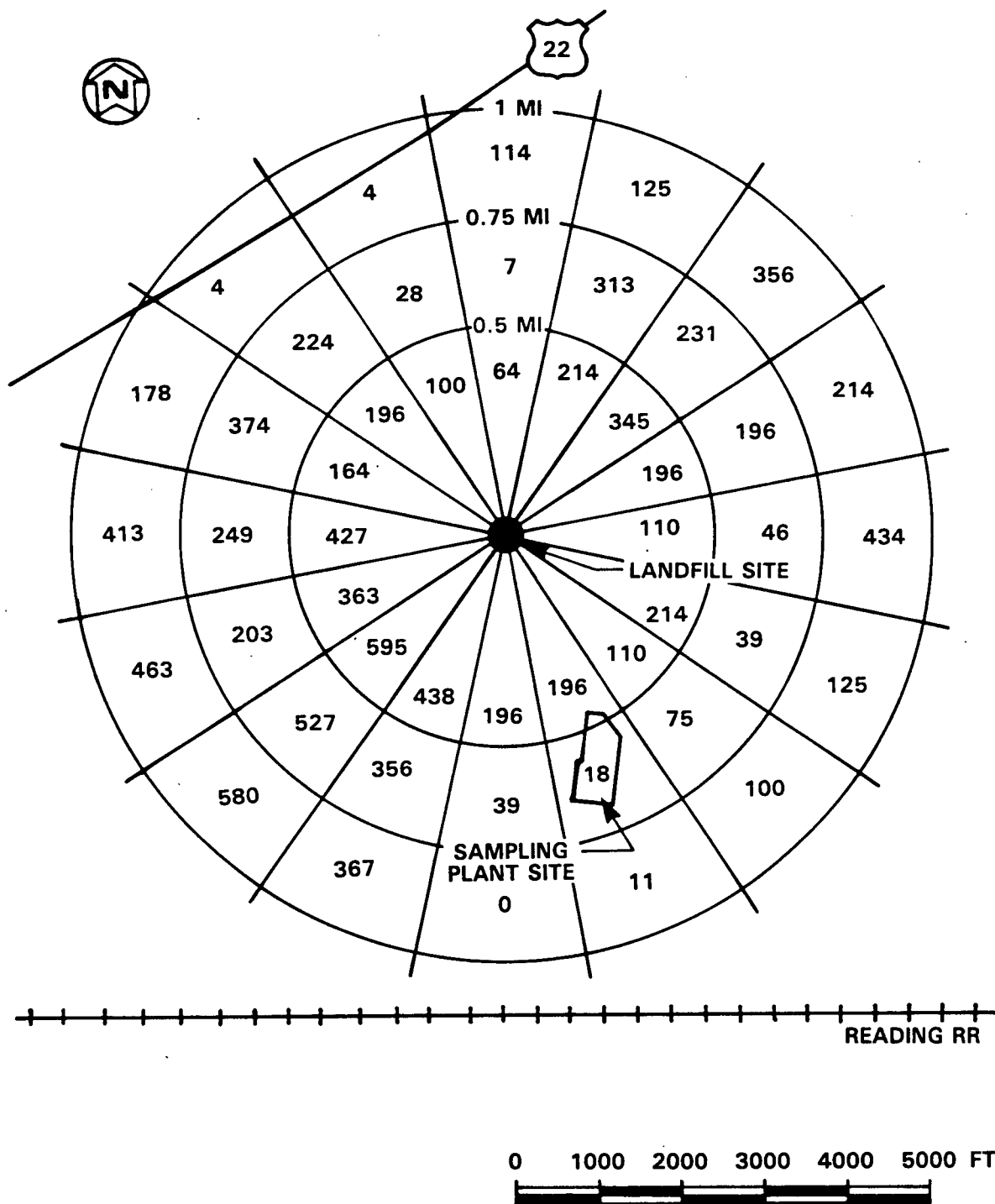


FIGURE 4-2 POLITICAL JURISDICTIONS AND MAJOR TRANSPORTATION ROUTES IN THE MSP VICINITY



SOURCE: FBDU 1979

FIGURE 4-3 POPULATION DISTRIBUTION AROUND MSP AND MML

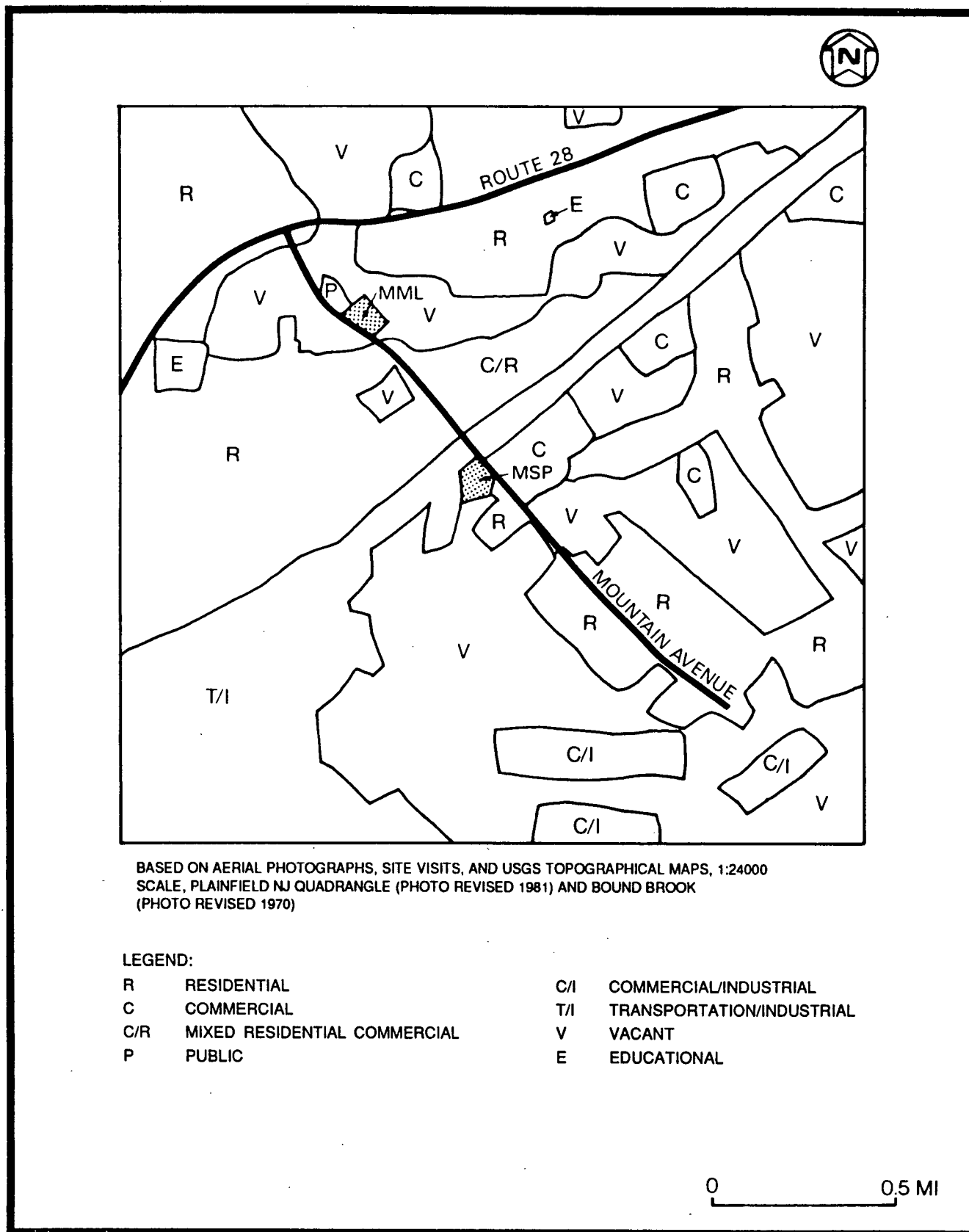


FIGURE 4-4 GENERALIZED LAND USES IN THE VICINITY OF MSP AND MML

5.0 STORAGE PILE CONSTRUCTION

As part of the remedial actions performed by NLO, an 11,100-m² (120,000-ft²) asphalt pad was constructed in the storage area. Because of the poor condition of the old pavement, a 2.5-cm (1-in.) leveling course of bituminous concrete was initially applied to the storage pile area. Then the 3.8-cm (1.5-in.) hot-mix bituminous-concrete top course, underlaid with a nonwoven paving grade polypropylene fabric, was subsequently installed over the asphalt-leveling course and rolled to achieve 95 percent Marshall density.

A 1.5-mm (60-mil) standard nylon-reinforced ethylene propylene diene monomer, manufactured by Carlisle Tire and Rubber, was installed as a cover for the contaminated materials. First, a 1-m- (3-ft-) wide perimeter tuck piece was bonded to the asphalt pad with cement. The edge pieces and border timbers were then spliced, cemented, and bolted together. The remainder of the liner was then put in place. Each lap splice was cleaned with unleaded gasoline prior to applying the jointing cement, according to the manufacturer's instructions. A minimum 15-cm (6-in.) lap was maintained for every splice. Upon completion of the splice, a lap sealant was applied to improve the integrity of the cemented-lap splice.

A different storage pile construction was employed for the waste from remedial action performed by BNI. A 45.7-cm- (18-in.-) high concrete curb was constructed around the perimeter of the storage area, and 15.2 cm (6 in.) of silty sand was placed within it to form a smooth, graded base. A 0.91-mm (36-mil) geomembrane liner was then placed on the sand and lapped up and attached to the top of the curb with battens. A 15.2-cm (6-in.) layer of permeable sand was then spread over the geomembrane to act as a leachate collection system, and contaminated material placement began. As portions of the storage area were completed, they were covered with a geomembrane stockpile cover. The battens attaching the bottom

liner to the curbs were removed; the cover and liner were sealed together; and the battens were reinstalled. The wastes were thus completely encapsulated by the geomembrane liner and cover. A sump riser was installed at the lower end of the storage pile to allow removal of any leachate that might collect in the collection system.

The collection system was provided only to collect water that exceeded the moisture-holding capacity of the material that was present in the contaminated material when the storage piles were constructed. If leachate is generated, it is collected by a commercial wastewater treatment facility for off-site treatment and disposal. No on-site treatment will take place. Approximately, 909 L (200 gal) of wastewater was removed from the leachate collection system after the piles were covered. No wastewater has been collected since, and none is anticipated.

6.0 SUMMARY OF CONTAMINATION

6.1 ORNL SURVEY

During 1976, a radiological survey of MSP was conducted by the Oak Ridge National Laboratory (ORNL). During this survey, measurements of activity were made in buildings and soil, and external gamma radiation levels were determined. Groundwater was not sampled.

6.1.1 Soil Survey

Soil samples were collected at 46 locations on the site and at 2 background locations. One of the background samples was collected in sandy soil across Mountain Avenue from the Municipal Building; the other sample was collected in the same type of soil that occurs at the site at the corner of Lincoln and Mountain Avenues. On-site radium-226 concentrations ranged from 0.8 to 477 pCi/g, compared with background levels of 1.0 pCi/g and 1.7 pCi/g. The highest concentration of radium-226 (2401 pCi/g) was found in the drainage ditch south of the site.

Examination of these data shows that, with the exception of 4 locations, radium-226 concentrations did not exceed 5 pCi/g below a depth of 0.6 m (2 ft). These locations are immediately west and south of the Process Building shown in Figure 3-1; the laboratory was located in this building. The maximum radium-226 concentration was 57 pCi/g at a depth of from 1.2 to 1.5 m (4 to 4.8 ft). It is likely that the elevated concentrations of radium-226 resulted from accidental spillage and discharges from the waste disposal system of the building.

6.1.2 Summary of ORNL Survey

In summary, the ORNL survey showed that contamination near the surface was widespread throughout the site and was more prevalent in the vicinity of the Process Building. Changes in radium-226

concentrations were abrupt, both laterally and vertically. Background concentrations for radium-226 in groundwater were 0.29 pCi/L.

6.2 WESTON SURVEY

During the Weston evaluation of the groundwater for ORNL in 1980, a radiological investigation was conducted. This investigation consisted of three elements:

- o Radiological logging of all boreholes
- o Analysis of soil and rock samples from the boreholes
- o Analysis of groundwater samples

The results of rock and soil sample analyses are presented in Table 6-1; results of groundwater analyses are presented in Table 6-2.

6.2.1 Subsurface Soil and Rock Survey

Figure 6-1 is a graph developed by Radiation Management Corporation, based on the samples collected at MSP, which provides a correlation between counts per minute (cpm) and radium-226 concentration. Based on this figure, it can be stated that 40,000 cpm is generally indicative of a radium-226 concentration over 5 pCi/g. Only two boreholes, DOE-2 and DOE-6, displayed activity above 40,000 cpm. This level of activity occurred in the upper 0.9 m (3 ft) in DOE-2 and throughout DOE-6. Note that in DOE-6A, which is within 3.0 m (10 ft) of DOE-6, activity was an order of magnitude less.

No measurement above the background range was found in the bedrock. Background for the site as indicated by the ORNL data is 1.3 pCi/g of radium-226. The highest concentration of radium-226 (793 pCi/g) was found in the parking lot subbase at DOE-13. The lowest concentration of radium-226 (0.568 pCi/g) was found in the clay at

TABLE 6-1

MSP REMEDIAL DECONTAMINATION PROJECT

SOLID SAMPLE ANALYSIS RESULTS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		Ra-226	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A Initial Site)	31387	341.	11	205.	10	44.0	10
DOE-1A #1 (Red Clay)	31389	14.5	64	38.2	13	0.734	17
DOE-1A #2 (Red Clay)	31388	32.2	39	41.5	12	3.54	10
DOE-2 Site (Asphalt)	31382	—	—	—	—	17.0	10
DOE-2 #1 (Fill Dirt)	31396	51.0	32	33.8	14	5.75	10
DOE-2 #2 (Red Clay)	31391	19.7	53	41.7	12	0.568	23
DOE-2 #3 (Subfill 1)	31393	29.1	42	27.8	16	4.99	10
DOE-2 #3 (Subfill 2)	31394	11.4	75	20.0	20	0.618	20
DOE-2 (Core 2.5-3.5 ft)	33917	38.2	33	32.7	12	—	—
DOE-2 (Core 4.0-5.0 ft)	33918	18.7	50	30.3	12	—	—
DOE-3A #1 (Sludge)	31385	18.4	54	26.9	15	0.590	22
DOE-4 #1 (Red Clay)	32768	9.38	73	23.5	17	1.05	16
DOE-5 #1 (Auger Soil)	32769	12.5	62	27.6	15	0.696	21
DOE-5 (Core 5.0-5.5 ft)	33919	<4.9	—	21.2	16	—	—
DOE-5A #1 (Red Clay)	31392	14.6	64	28.1	16	0.761	19
DOE-6 (Core 1.0-2.5 ft)	33921	212.	13	185.	10	—	—
DOE-6 (Core 2.5-4.3 ft)	33922	63.4	25	42.7	10	—	—
DOE-6 (Core 4.3-6.0 ft)	33923	6.38	10	4.94	10	—	—
DOE-6 (Core 6.0-7.5 ft)	33924	2.47	43	2.43	15	—	—
DOE-6A #1 (Gray Mud)	31395	1.77	63	2.36	18	2.02	11
DOE-6A #2 (Red Clay)	31390	1.45	64	2.73	15	0.575	21
DOE-7 #1 (Auger Soil)	32770	4.74	30	7.99	10	1.95	12
DOE-7 (Core 3.0-5.0 ft)	33930	5.14	30	7.78	10	—	—
DOE-8 #1 (Tailings)	32771	2.19	43	2.30	18	3.02	10
DOE-10 #1 (Subasphalt)	32765	1.31	10	2.42	10	793.	10
DOE-11 #1 (Auger Soil)	32766	2.20	49	3.77	12	14.7	10
DOE-13 #1 (Auger Soil)	32767	9.93	20	8.66	10	1.98	12
DOE-14 (Core 0.5-1.5 ft)	33935	7.52	23	6.25	10	—	—
DOE-14 (Core 3.5-4.0 ft)	33936	2.25	45	3.81	11	—	—

TABLE 6-1
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	52.3	9	2.06	23	54.9	9
DOE-1A #1 (Red Clay)	31389	1.03	28	0.063	—	0.611	38
DOE-1A #2 (Red Clay)	31388	1.69	15	0.182	44	1.40	16
DOE-2 #1 (Fill Dirt)	31396	10.2	11	0.420	43	1.04	11
DOE-2 #2 (Red Clay)	31391	0.897	33	<0.14	—	0.874	34
DOE-2 #3 (Subfill 1)	31393	18.6	12	<0.56	—	18.2	17
DOE-2 #3 (Subfill 2)	31394	1.07	25	0.061	—	0.548	33
DOE-4 #1 (Red Clay)	32768	1.22	23	<0.14	—	1.33	23
DOE-5 #1 (Auger Soil)	32769	5.38	15	<0.21	—	4.04	17
DOE-6A #1 (Gray Mud)	31395	3.27	6	0.225	52	2.75	16
DOE-6A #2 (Red Clay)	31390	0.560	38	0.057	—	0.618	36
DOE-7 #1 (Auger Soil)	32770	2.30	17	0.080	—	2.00	20
DOE-8 #1 (Tailings)	32771	4.80	13	0.187	54	4.39	13
DOE-10 #1 (Subasphalt)	32765	329.	11	<0.21	285.	33	
DOE-11 #1 (Auger Soil)	32766	6.59	14	0.289	52	7.07	13
DOE-13 #1 (Auger Soil)	32767	17.0	9	0.412	38	16.5	10

TABLE 6-1
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	490.	20	9.18	42
DOE-1A #1 (Red Clay)	31389	50.1	62	9.19	48
DOE-1A #2 (Red Clay)	31388	7.52	24	3.62	33
DOE-1A #3 (Sludge)	31386	8.46	30	6.07	35
DOE-2 #1 (Fill Dirt)	31396	63.2	20	6.28	40
DOE-2 #2 (Red Clay)	31391	5.26	44	8.24	37
DOE-2 #3 (Subfill 1)	31393	164.	21	7.32	49
DOE-2 #3 (Subfill 2)	31394	4.66	52	7.67	43
DOE-4 #1 (Red Clay)	32768	13.1	34	8.59	37
DOE-5 #1 (Auger Soil)	32769	4.13	44	6.37	37
DOE-6A #1 (Gray Mud)	31395	22.2	27	5.78	43
DOE-6A #2 (Red Clay)	31390	3.04	56	5.21	44
DOE-7 #1 (Auger Soil)	32770	7.85	32	4.93	39
DOE-8 #1 (Tailings)	32771	50.3	24	14.1	32
DOE-10 #1 (Subasphalt)	32765	2690.	16	6.70	37
DOE-11 #1 (Auger Soil)	32766	58.4	22	6.31	43
DOE-13 #1 (Auger Soil)	32767	111.	18	5.57	39

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey—Final Report, October 1980.

TABLE 6-2
MSP GROUNDWATER QUALITY ANALYSIS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		RA-226	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	56.3	21	<2.3	—	0.439	45
DOE-3A	32755	49.5	21	16.2	18	0.729	36
DOE-4	32760	4.54	75	3.98	62	0.237	57
DOE-4A	32757	11.2	44	58.7	10	0.450	56
DOE-5	32761	8.82	53	8.56	32	0.118	94
DOE-5A	32758	<1.8	—	20.0	17	0.187	91
DOE-6 7/3/80	32762	2740.	10	432.	10	474.	10
DOE-6A 7/3/80	32759	6.47	75	<2.4	—	0.219	70
DOE-6 7/31/80	35788	3050.	10	—	—	—	—
DOE-6A 7/31/80	35805	13.5	50	15.9	18	—	—
DOE-8	32763	66.7	19	15.6	20	1.94	20
DOE-9	35789	17.3	28	6.27	10	—	—
DOE-11	35790	4.19	60	4.33	51	—	—
DOE-12	35791	<1.48	—	<2.02	—	—	—
DOE-13	35792	<1.83	—	130.0	10	—	—
DOE-14	32764	5.99	75	<2.30	—	—	26

TABLE 6-2
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	6.36	24	<0.54		4.44	28
DOE-3A	32755	21.2	15	0.93	64	18.9	15
DOE-4	32760	0.655	10	<0.45		0.940	63
DOE-4A	32757	10.4	19	<0.70		12.0	18
DOE-5	32761	6.34	25	<0.27		5.24	27
DOE-5A	32758	1.77	45	<0.58		1.06	58
DOE-6	32762	1420.	10	<54.0		1430.	10
DOE-6A	32759	4.72	28	<0.57		2.45	38
DOE-8	32763	38.6	12	1.46	50	41.3	11
DOE-14	32764	1.98	43	<0.27		2.97	35

TABLE 6-2
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-3A	32755	6.98	40	9.08	36
DOE-4	32760	<4.5	—	<1.5	—
DOE-4A	32757	31.6	41	<5.5	—
DOE-5	32761	<9.0	—	<3.4	—
DOE-5A	32758	5.95	52	10.5	41
DOE-6	32762	115.	24	<5.3	—
DOE-6A	32759	<8.8	—	<5.4	—
DOE-8	32763	<4.7	—	<10.	—
DOE-14	32764	13.8	73	<5.2	—

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Site, Middlesex, New Jersey—Final Report, October 1980.

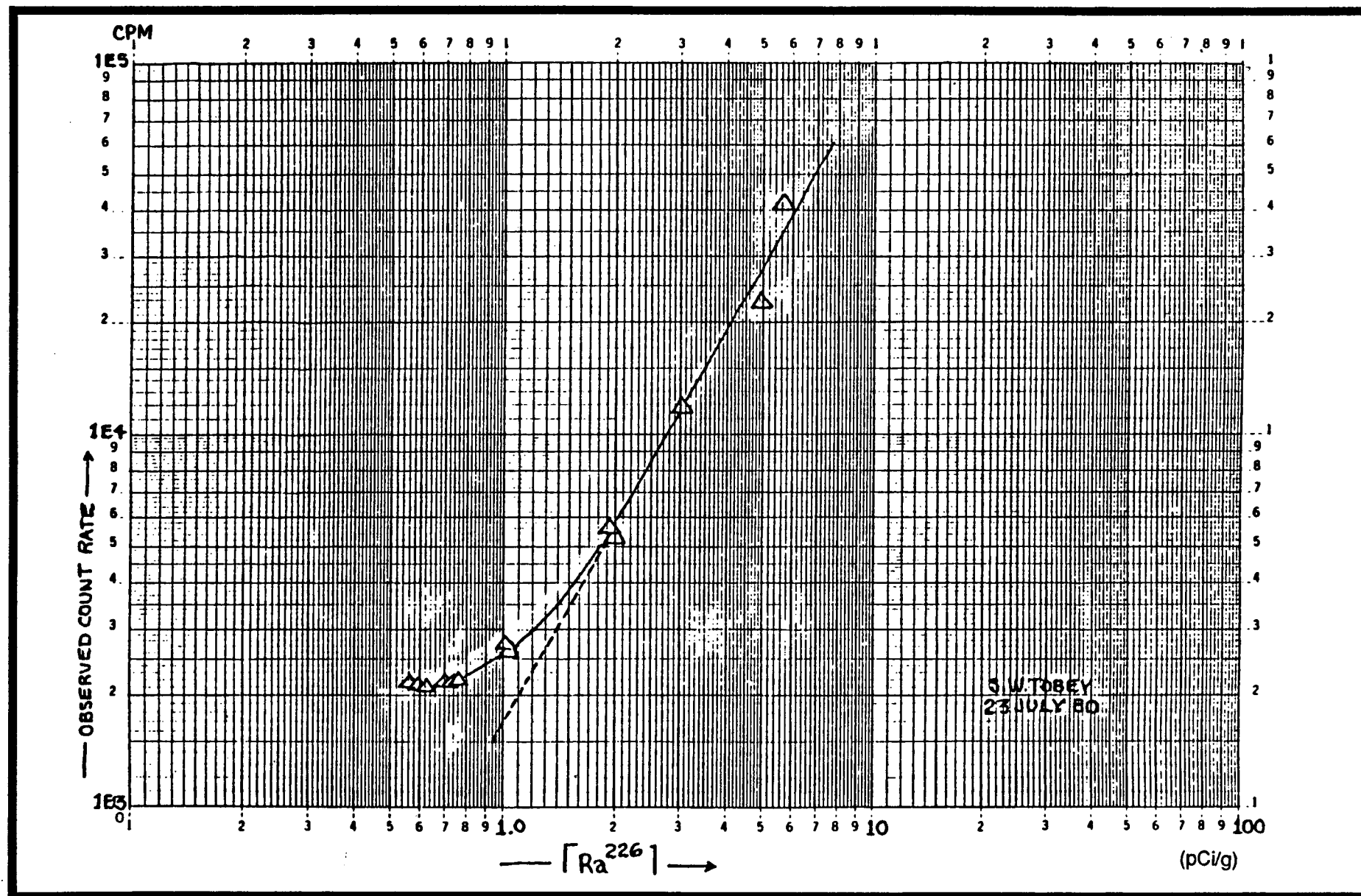


FIGURE 6-1 CORRELATION OF RADIUM CONCENTRATION AND
COUNTS PER MINUTE

DOE-2. No ORNL data were available for comparison at these locations.

Most soil samples contained low levels of radium-226, usually an order of magnitude below 5 pCi/g. All clays sampled were below this level as were the subfill samples. The asphalt sample from DOE-2 was high at 17.0 pCi/g.

The concentrations of uranium-238 in soil samples ranged from 0.518 to 285.0 pCi/g. The highest concentration was found in the subbase at DOE-10, which also had the highest radium-226 concentration. The lowest level (0.518 pCi/g) was found in the subfill-2 sample from DOE-2.

Comparison of these Weston data with the earlier ORNL data shows close agreement over most of the area. Both sets of data show that the upper 0.6 to 0.9 m (2 to 3 ft) of the site are the most active, with some exceptions.

Discrepancies exist between the two sets of data for high activity levels; high activity levels at a location in one set of data are not confirmed by nearby samples in the other set of data. Both sets of data do show that contamination is extremely localized (DOE-6 and DOE-6A, for example).

6.2.2 Groundwater Survey

Analysis of the groundwater on the site shows that groundwater in DOE-6 has the highest activity. Background, as determined by ORNL, is 0.29 pCi/L for radium-226. Water in six of ten wells showed radium-226 concentrations above this level. As shown in Table 6-2, with the exception of DOE-6, DOE-8, and DOE-14, the other boreholes are only slightly above background. Activity in the soil at DOE-6 has already been described. Since DOE-6 shows high levels of contamination that are not found in other boreholes, it is suspected that this borehole may have been contaminated with surface contamination during drilling. In DOE-8, an elevation in activity

from 0.7 to 1.1 m (2.3 to 3.6 ft) appears below the surface. DOE-14 is located adjacent to the ditch that has received most of the site drainage. This area appears to have been severely impacted by the deposition of contaminated soil that had been transported as suspended particles via surface water runoff and lateral transport through the parking lot subbase.

6.2.3 Summary of Weston Survey

In summary, the 1980 data show that radiological contamination in the soil on the site exists primarily in localized pockets that seldom extend beyond the site. This contamination only rarely occurs at depths greater than 0.9 m (3 ft) below the surface. The area of highest incidence of contamination is in the vicinity of the main building.

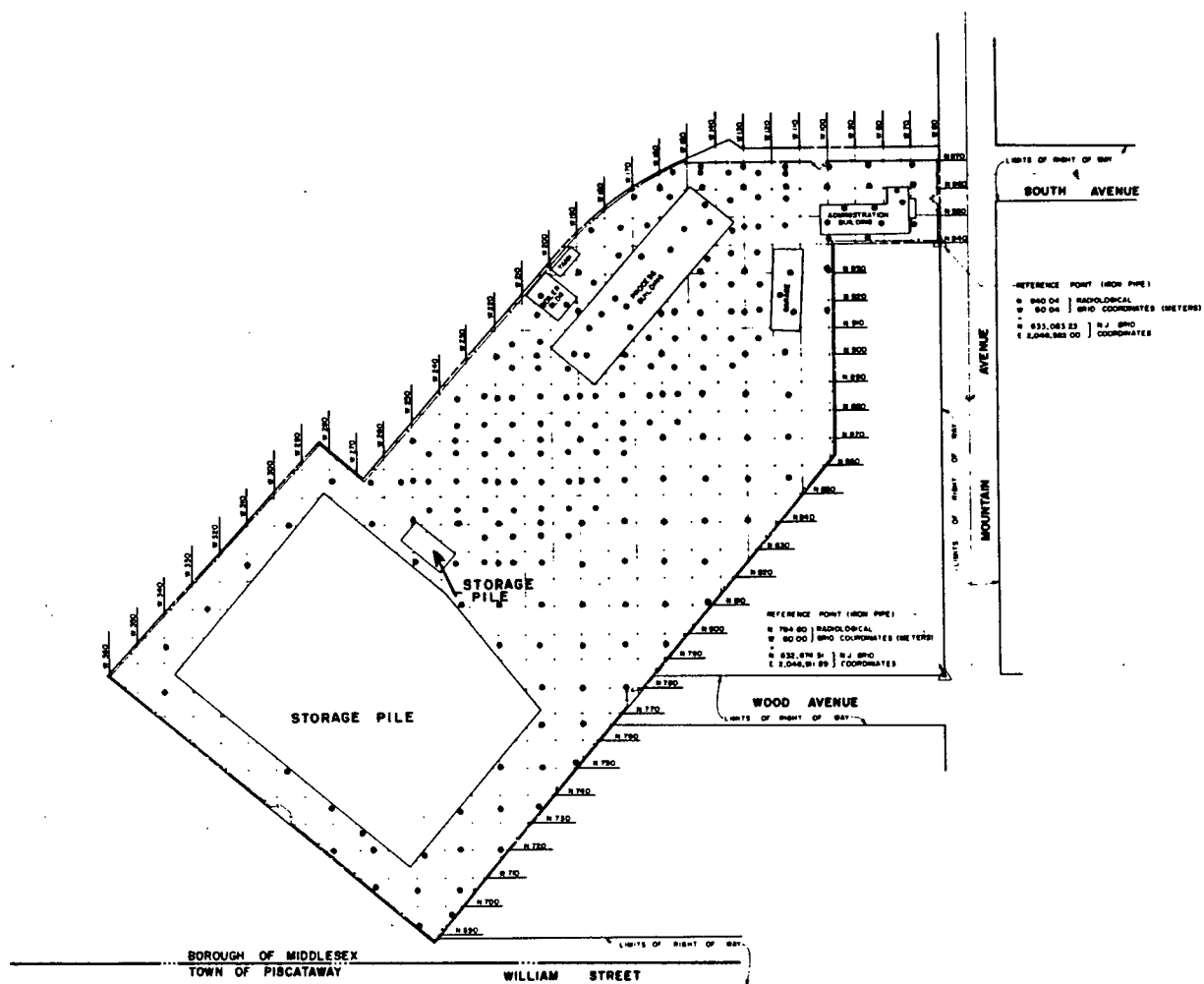
6.3 BNI SURVEY

In 1983, a radiological characterization of the MSP property was conducted by BNI. The survey characterized the boundaries and extent of contamination at the MSP property. It included both horizontal and vertical characterization of the grounds.

Indoor measurements were also made of the four buildings on the property: the process building, boiler house, administration building, and garage. Building exteriors were monitored in the same manner as the interiors. Surface measurements indicated extensive fixed alpha contamination in the process building and the boiler house. Surface measurements obtained in the garage and the administration building identified several areas of elevated levels of contamination in each building.

6.3.1 Soil Survey

Prior to 1986, boreholes were drilled over the entire site on a 15-m (50-ft) grid as shown in Figure 6-2. On-site areas excluded from drilling were those under the storage piles located on the southern



NOT TO SCALE

LEGEND:

• BOREHOLE

FIGURE 6-2 BOREHOLE LOCATIONS AT THE FORMER MSP SITE

portion of the asphalt storage pad and a 0.6-m- (2-ft-) wide strip along the inside of the perimeter fence that had been excavated during earlier remedial action activities. The boreholes were drilled to the soil-shale interface, temporarily cased with a polyvinyl chloride tube, and gamma logged.

All soil samples (except for those around the administration building) will be considered subsurface samples in view of the thickness of asphalt covering the site. The majority of soil samples were analyzed on site for uranium-238, radium-226, and thorium-232 in the mobile laboratory.

All direct field survey measurements and laboratory results represent gross readings; background measurements and concentrations were not subtracted. Background levels applicable to Middlesex have been previously measured. Statewide New Jersey background soil concentrations in pCi/g have been measured as 0.86 for radium-226, 0.89 for thorium-232, and 0.87 for uranium-238.

Both beta-gamma dose rate measurements made at the ground-surface and near-surface gamma radiation measurements were used to define the areal extent of contamination. Beta-gamma dose rate measurements ranged from <0.01 to 7.25 mrad/h.

Elevated, near-surface gamma-radiation measurement readings are those that are equal to or greater than twice background. These readings would be, under normal circumstances, correlated with soil sample analysis to establish a calibration factor relating the detector's response in cpm to the specific radionuclide concentration in pCi/g. Because MSP is covered with varying thicknesses of asphalt, a correlation factor could not be determined. However, high gamma readings generally related to elevated concentrations of radionuclides in the soil. Results were determined for uranium-238, radium-226, and thorium-232. The maximum concentration for uranium-238 was 961 pCi/g. The maximum radium-226 concentration was 736 pCi/g. The maximum thorium-232 concentration was 19.3 pCi/g.

The major contaminants in soil samples taken from borings were uranium-238 and radium-226. The maximum uranium-238 concentration was 398 pCi/g; the maximum radium-226 concentration was 208 pCi/g. Correlations between concentrations of radionuclides in soil samples and borehole gamma count rates were used to determine the depth of contamination.

6.3.2 Process Building

The concrete dock and roof along the east side of the process building were monitored in the same manner as the floors. The inside surface of the roof parapet and its ceramic top were monitored at 2.5-m (8.2-ft) intervals.

In the process building, approximately 90 percent of the measurements taken on the interior and exterior surfaces indicated elevated levels of alpha contamination. The maximum reading observed was 40,256 dpm/100 cm². The maximum beta-gamma dose rate observed was 1.43 mrad/h.

The maximum radon flux measurement was 168 pCi/(m²·s); for time-integrated radon, the measurement was 3.54 pCi/L.

Subsurface soil samples from boreholes drilled through the first floor indicated contaminated soils at a depth of 1.4 m (4.5 ft). This depth corresponds to the original grade prior to installation of a concrete floor in the building.

6.3.3 Boiler House

In the boiler house, readings from interior floors, walls, and the floor-wall intersections indicated elevated levels of alpha contamination in some areas. The maximum interior alpha surface measurement observed was 799 dpm/100 cm².

Miscellaneous measurements taken on inside heaters, pipes, and beams showed some alpha contamination with a maximum reading of 5,049 dpm/100 cm².

The maximum radon flux measurement was 8.93 pCi/(m²·s); for time-integrated radon, the measurement was 0.53 pCi/L.

Three exterior walls were surveyed--the west exterior wall was inaccessible. The maximum alpha surface measurement was 6,494 dpm/100 cm².

The roof showed scattered contamination; the maximum measurement for alpha surface contamination was 272 dpm/100 cm².

6.3.4 Administration Building

In the administration building, interior measurements were taken on the floor, at the floor-wall intersections, on the drains, and at random locations on the walls. The maximum alpha surface measurement observed was 3,536 dpm/100 cm².

The maximum radon flux measurement was 0.15 pCi/(m²·s); time-integrated radon was nondetectable.

A few areas of elevated alpha readings were found and will require decontamination.

6.3.5 Garage

Interior measurements were taken on the floors, at the floor-wall intersections, and on miscellaneous items inside the garage. The maximum alpha level, 5,015 dpm/100 cm², was observed on a heater.

Radon flux data were lost during processing, and time-integrated radon was nondetectable.

Exterior measurements were taken on the garage roof. Elevated alpha readings were observed in two areas. The maximum measurement was 204 dpm/100 cm².

6.4 MISCELLANEOUS ENVIRONMENTAL MONITORING

In 1983, samples were taken from several of the borings. These samples were analyzed for uranium-238 and radium-226 at the Eberline Instrument Corporation in Albuquerque, New Mexico. The uranium-238 concentration ranged from 1.5 to 1,288 pCi/L; the radium-226 concentration ranged from <0.1 to 71.0 pCi/L.

Gamma exposure rates were measured using a pressurized ionization chamber (PIC) at 1 m (3.3 ft) above the ground. The exposure rates ranged from 16 to 371 μ R/h. As noted earlier, the natural background gamma exposure rate was measured as 6.1 μ R/h.

A surface-activity radiation survey of the mosquito control ditch was conducted in the first quarter of 1986 (Figure 6-3). Samples were taken at the plant outfall, at the confluence, and downstream of the confluence. The concentration of uranium-238 in the sediments ranged from 0.8 to 38.7 pCi/g. The concentrations of radium-226 in the sediments ranged from 0.4 to 42.0 pCi/g. A resurvey was conducted of the locations in July 1987, which indicated that the high results obtained in the first quarter of 1986 were not representative of the conditions of the locations sampled and that those data were anomalous.

The average annual radon-222 concentrations measured at the MSP boundaries using Terradex Monitors do not exceed background. Station 6 is located on the external wall of the process building and, as a result, detects radon at higher levels than any of the perimeter stations. Station 6 has a potential bias because it is located on the east corner of the process building loading dock. Ores that are good radon generators are assumed to be present between the dock and the building. The 1987-1988 data from Station 6 and other stations are listed in Table 6-3. Sampling locations are shown in Figure 6-4.

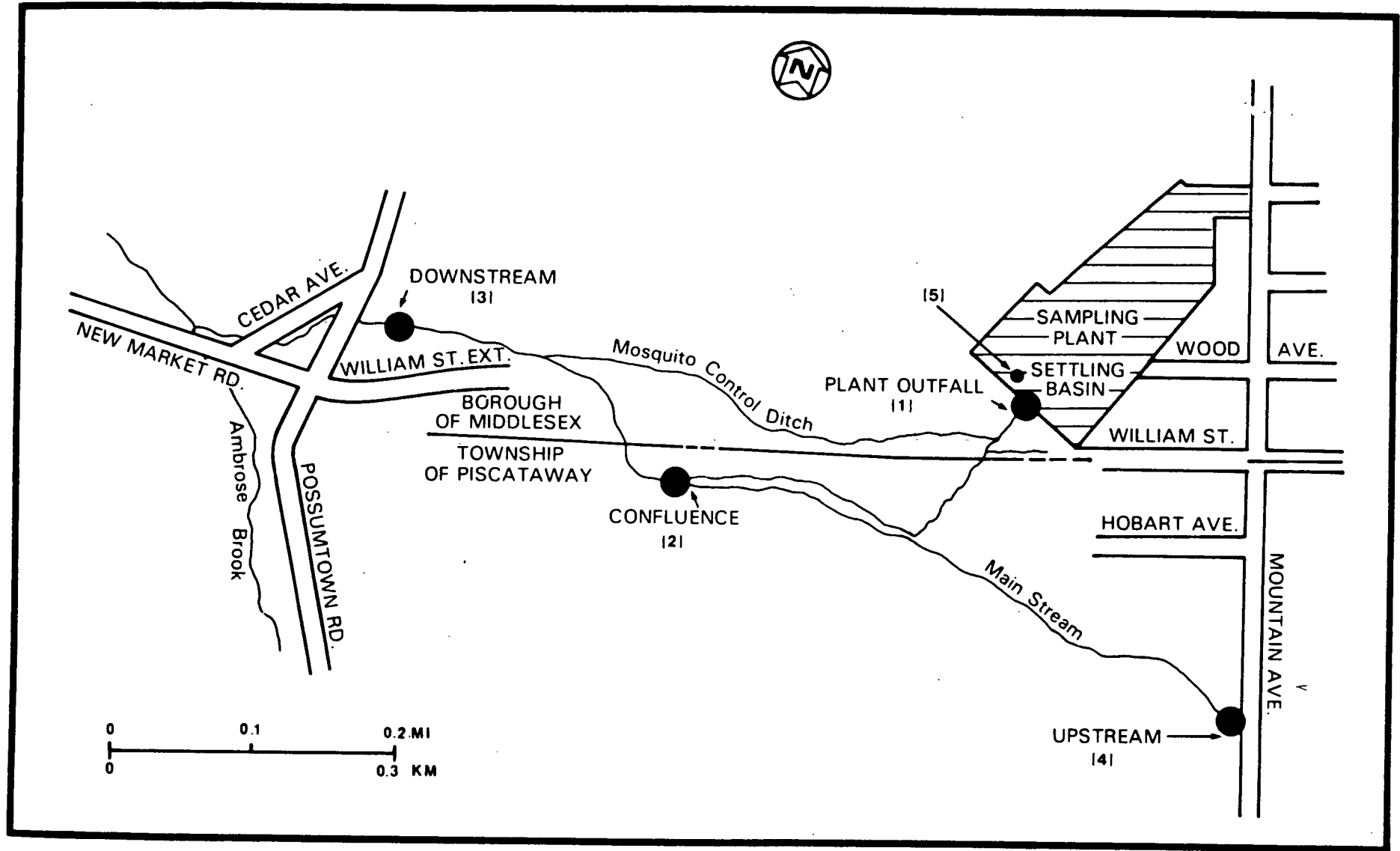


FIGURE 6-3 LOCATION OF THE MOSQUITO CONTROL DITCH

TABLE 6-3
RADON-222 CONCENTRATIONS MEASURED AT MSP
USING TERRADEX MONITORS, 1987-1988

Sampling Month	Sampling Station Concentration (pCi/L)				
	2	4	6	9	10
April 1987	1.1	1.1	6.6	0.2	0.3
July 1987	0.4	0.2	16.0	0.1	0.1
October 1987	1.4	0.4	3.3	0.5	0.6
January 1988	0.4	0.9	5.7	1.0	0.2
April 1988	0.4	0.5	2.5	0.9	0.7

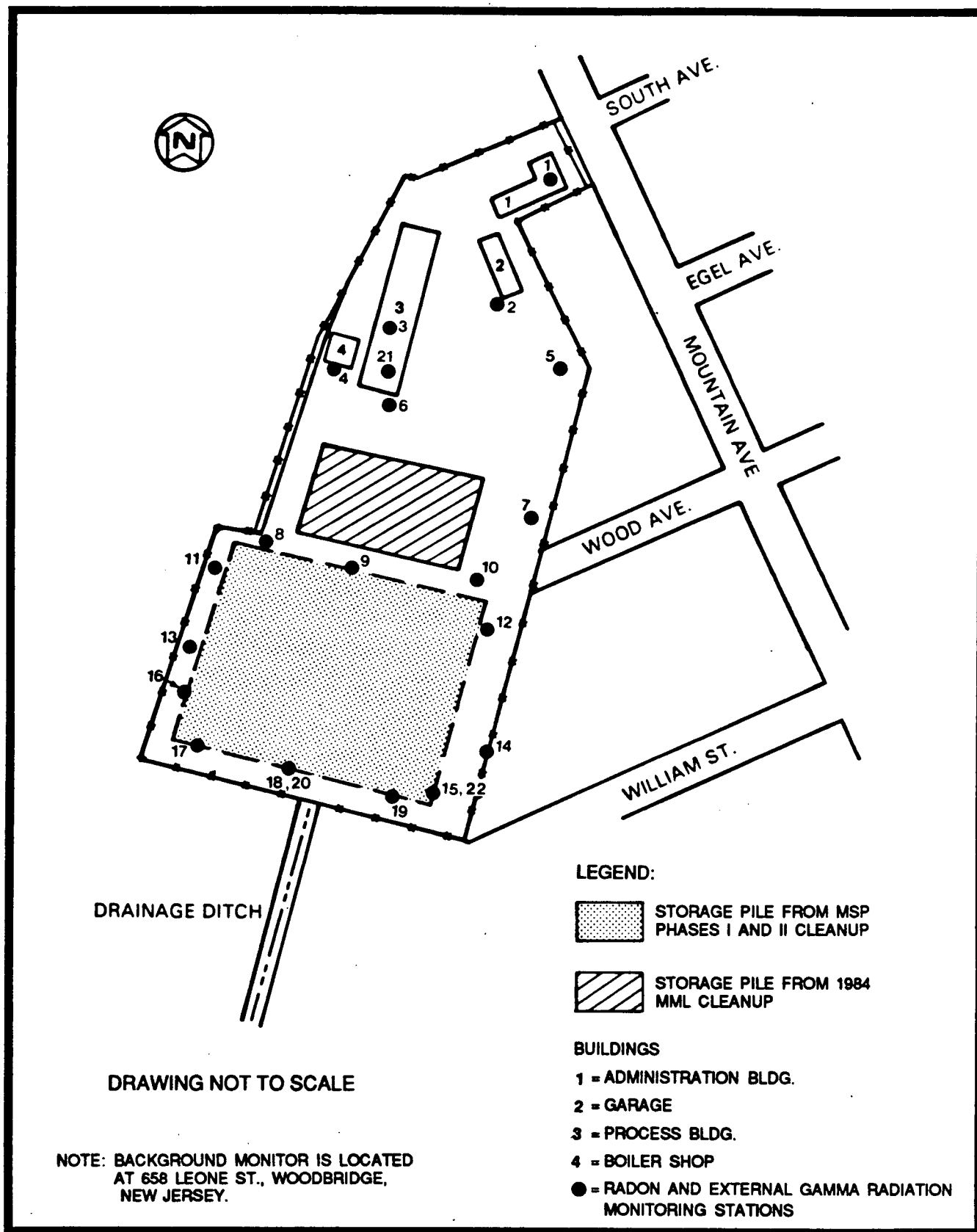


FIGURE 6-4 RADON (TERRADEX) AND EXTERNAL GAMMA RADIATION MONITORING LOCATIONS AT MSP

In 1987, BNI surveyed the external gamma radiation level at the fenceline using a PIC 1 m (3.3 ft) above the ground. At the location of the maximum dose rate measured, 293 mrem/yr, a person could stay 8 hpd and still not exceed the annual allowable exposure of 100 mrem/yr. This scenario is considered the maximum potential risk to the general public from MSP.

7.0 REMEDIAL ACTION

Remedial action at MML was conducted in two phases, in 1984 and 1986. Excavation of contaminated soil from the landfill began during the summer of 1984, and by November of that year, approximately $11,500 \text{ m}^3$ ($15,000 \text{ yd}^3$) had been removed to MSP. Excavation was halted in November 1984, and backfilling was completed. Excavation resumed in May 1986 and was completed in July of that year. The amount of material removed during 1986 was approximately equivalent to that excavated in 1984, bringing the total amount of contaminated material excavated from the landfill to $23,700 \text{ m}^3$ ($31,000 \text{ yd}^3$).

In 1981, remedial action included the decontamination of the Rectory and 432 William Street and restoration to the "as was" condition. Also included in the project was the erection of a temporary storage pile at MSP and containment of the pile with a moisture-impervious liner and cover.

DOE also decontaminated three additional properties; the Rectory Playground, Kays (312 Mountain Avenue), and Rosamilia (Wood Avenue) properties. The contaminated materials from these sites were included in the temporary MSP storage pile.

The volume of excavated material is presented in the Table 7-1. The location of these properties is shown in Figure 7-1. The locations of storage piles at MSP are shown in Figure 7-2.

The compacted volume from the properties is equal to the Phase I volume in Table 3-1 after the site improvement volume is subtracted ($10,646 - 1,225 = 9,421 \text{ yd}^3$).

Detailed information regarding the remedial action performed in 1981 is included in Project Report of Phase I Remedial Action of Properties Associated with the Former Middlesex Sampling Plant Site (NLCO-DOO6EV).

TABLE 7-1
EXCAVATED VOLUME OF CONTAMINATED SOIL AT MSP

Area	Estimated Quantity ^a m ³ (yd ³)	Excavated Quantity m ³ (yd ³)	Compacted Quantity (Storage Pile) m ³ (yd ³)
Site (Resulting from Improvements Placed by Reid)	382 (500)	937 (1,225)	937 (1,225)
Rectory	1,376 (1,800)	4,544 ^b (5,943)	3,181 (4,160)
Williams Street	382 (500)	1,361 ^b (1,780)	953 (1,246)
Playground	153 (200)	170 ^b (223)	119 (156)
Rosamilia	2,294 (3,000)	4,070 ^b (5,323)	2,849 (3,726)
Kays	153 (200)	145 ^b (190)	102 (133)
TOTAL	4,740 (6,200)	11,227 (14,684)	8,141 ^c (10,646)

^aThe estimated quantities are based on the criterion set for MSP of 5 pCi/g of radium-226. Actual final levels of radium-226 were lower than 5 pCi/g as a result of sampling, instrument, and statistical considerations in applying the criterion, as described in Section 8.0.

^bThese quantities reflect the excavation quantities removed from the properties by the contractor.

^cThis figure represents the final compacted volume of the Phase I pile and has been verified by Ford, Bacon, Davis & Utah, Inc., field engineers.

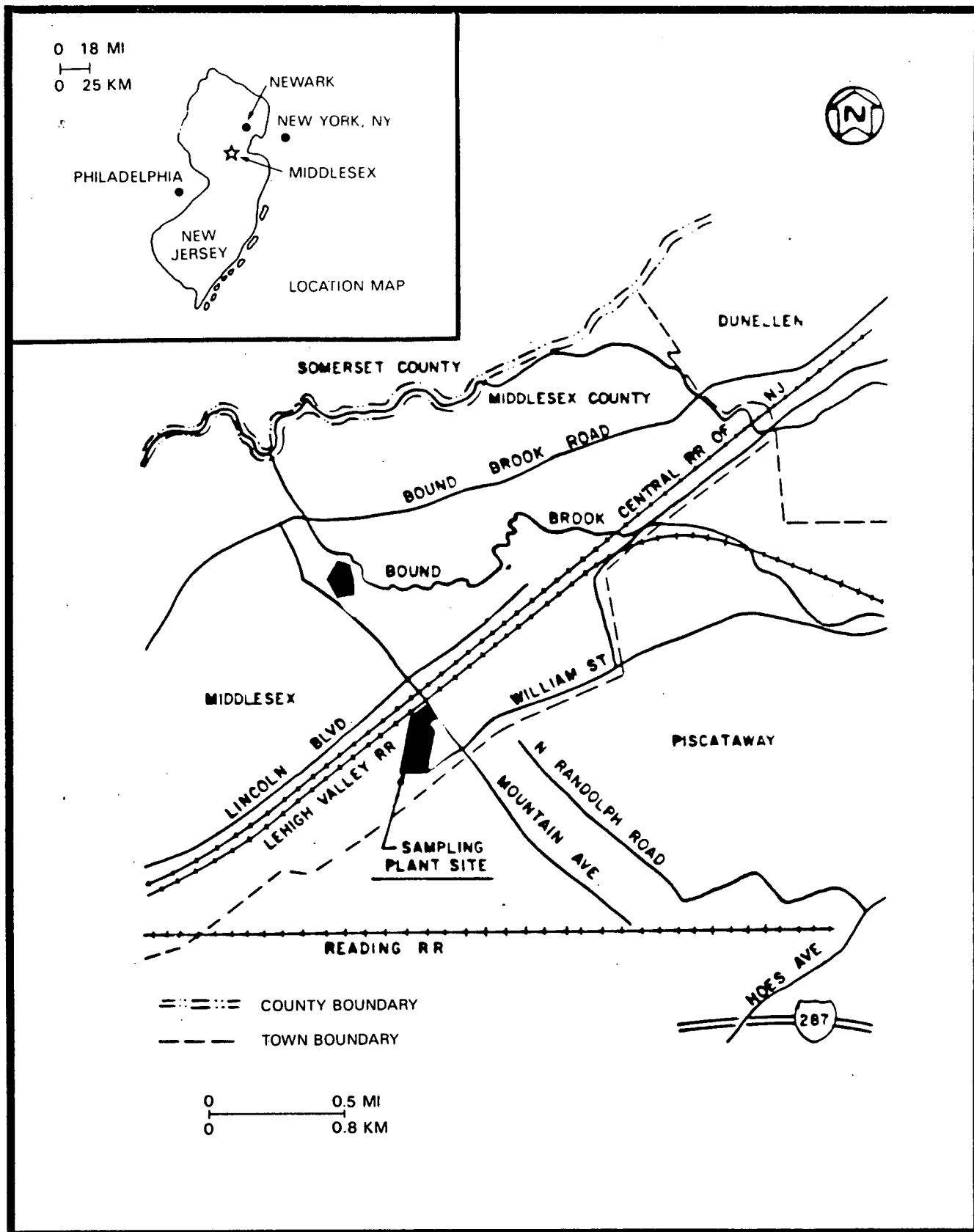


FIGURE 7-1 LOCATION OF THE MSP, MML, AND PREVIOUSLY CONTAMINATED PROPERTIES

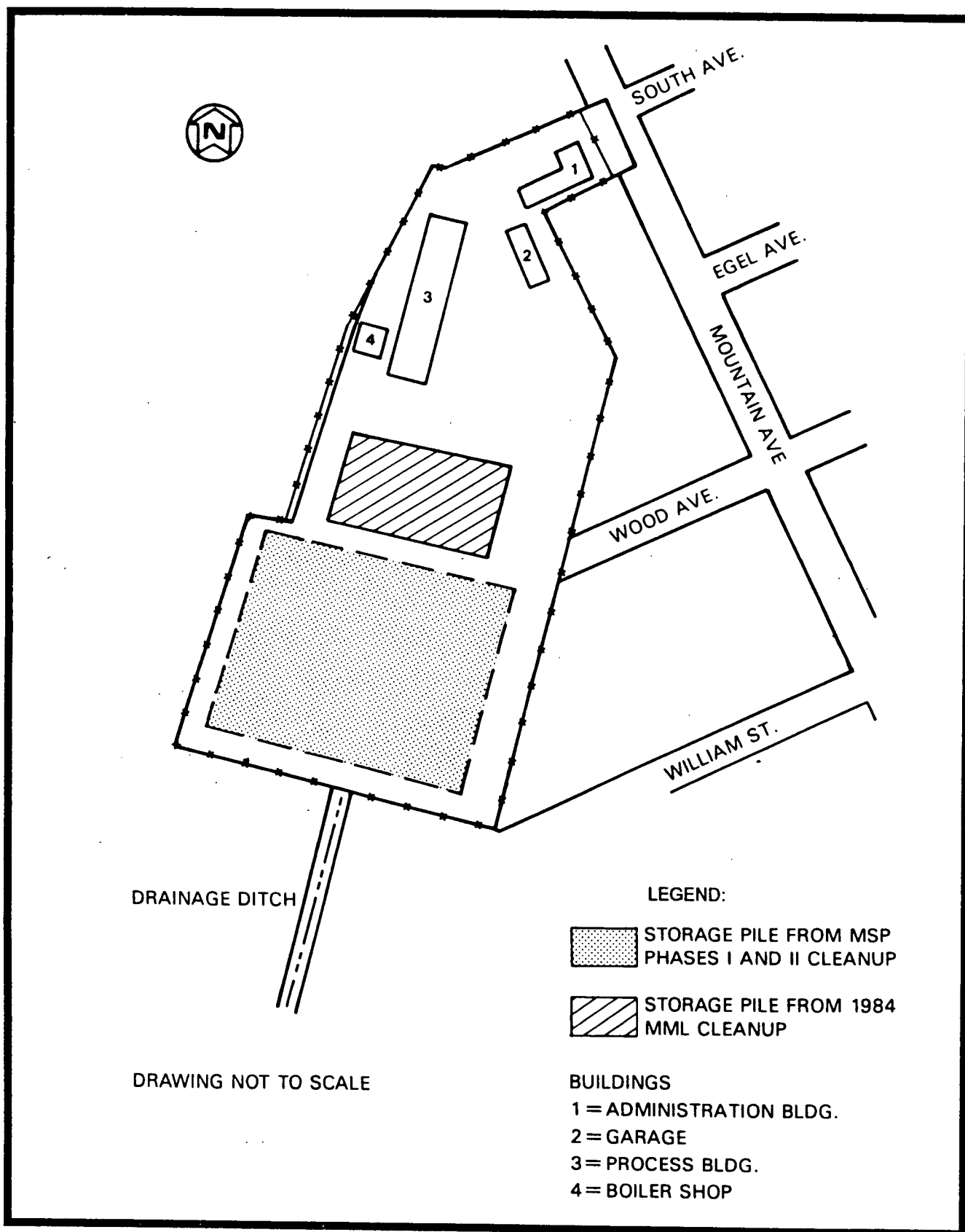


FIGURE 7-2 STORAGE PILES AT THE MSP SITE

The area where remedial action was performed in 1984 is shown in Figure 7-3. It includes residential, commercial, industrial, and unimproved lands. The buildings on these properties were not contaminated. Measurements showed that the contamination was primarily limited to the ground surface, indicating that wind and water were the primary modes of transport from the former MSP. Spread of radioactive material also resulted from physical transportation of soils during previous construction and demolition at the site.

Properties south of the site are in a wooded area that serve as a drainage basin for the vicinity. Most of the excavation occurred in this area. A drainage ditch flows past the south end of the site and then 180 m (600 ft) to Main Stream. Main Stream flows southwesterly past the site through a heavily wooded area for approximately 850 m (2,800 ft) before joining Ambrose Brook.

Contaminated soil was removed and transported from the adjacent and vicinity properties, including the above-mentioned wooded drainage area, and placed in the storage pile at the former MSP. A total of 19,700 m³ (25,700 yd³) of contaminated soil was excavated. The soils were specifically obtained from the following locations:

1. Residential parcels along Mountain Avenue
2. Wooded property between Wood and William Street
3. Residence on Parcel 17 and William Street roadbed
4. South drainage area
5. Main Stream area

Contaminated soil was excavated to the extent necessary to remove soil with levels greater than 5 pCi/g of radium-226 above background.

Details regarding each vicinity property remediated during Phase II are included in Volume 2 of the Final Report on Phase II Remedial Action at the Former MSP and Associated Properties, Middlesex, New Jersey.

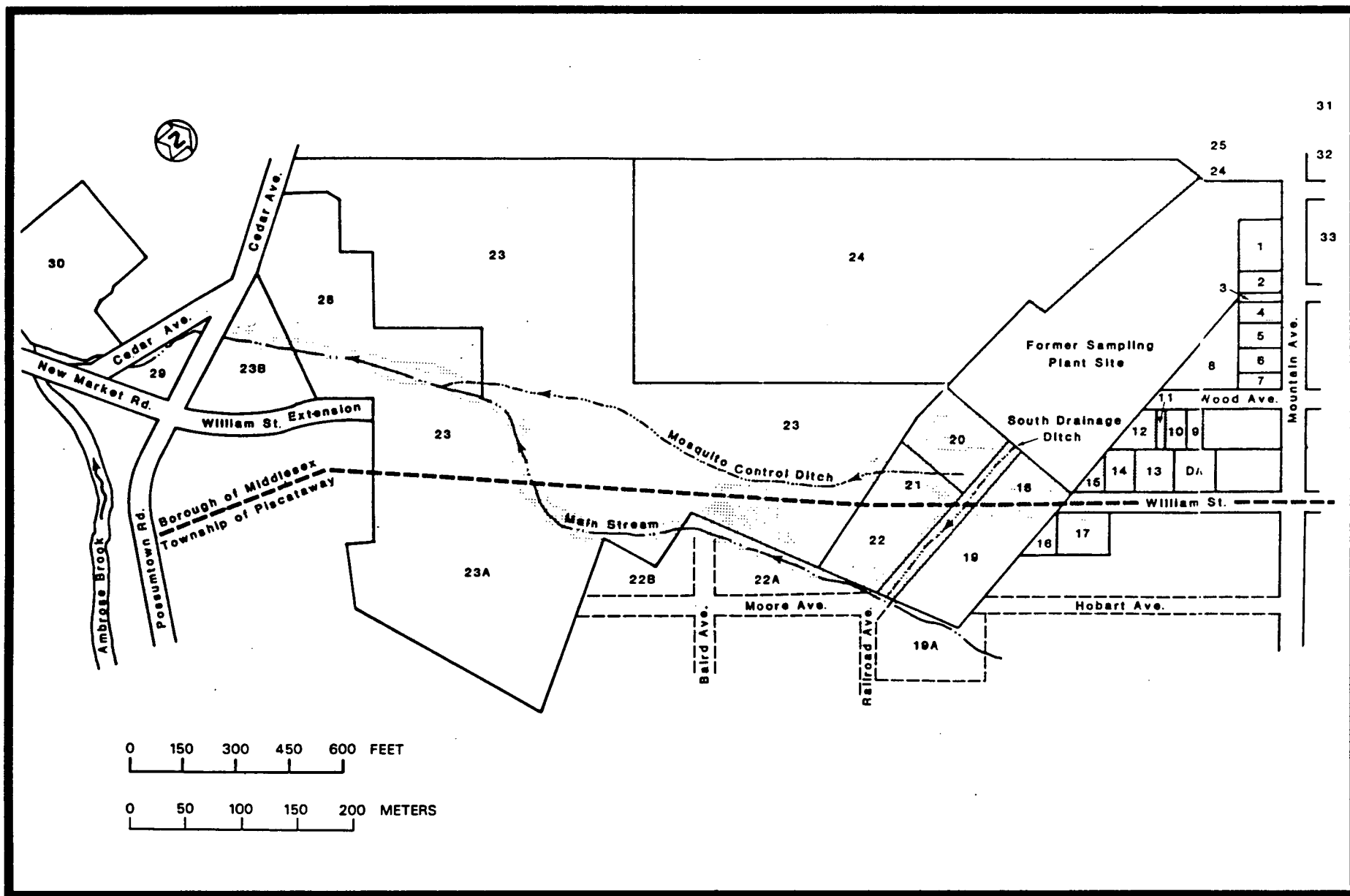


FIGURE 7-3 MAP OF MIDDLESEX PHASE II REMEDIAL ACTION PROPERTIES

8.0 BIBLIOGRAPHY

1. U.S. Department of Energy, Draft Certification Docket for the Remedial Action Performed at Vicinity Properties in Middlesex, New Jersey, in 1984 and 1986, May 1987.
2. U.S. Department of Energy, Draft Preliminary Engineering Evaluation of Remedial Action Alternatives, Middlesex Municipal Landfill, Middlesex, New Jersey, September 1982.
3. U.S. Department of Energy, Final Report on Phase II Remedial Action at the Former Middlesex Sampling Plant and Associated Properties Middlesex, New Jersey, DOE/OR/20722-27 (Vol. 2), April 1985.
4. U.S. Department of Energy, Final Report on Phase II Remedial Action at the Former Middlesex Sampling Plant and Associated Properties, Middlesex, New Jersey, DOE/OR/20722-27 (Vol. 1), April 1985.
5. U.S. Department of Energy, Formerly Utilized MED/AEC Sites Remedial Action Program, Environmental Analysis of the Middlesex Municipal Landfill Site, Middlesex, New Jersey, FBDU 230-009, July 1979.
6. U.S. Department of Energy, Formerly Utilized MED/AEC Sites Remedial Action Program Environmental Assessment of the Properties Adjacent to and Nearby the Former Middlesex Sampling Plant, Middlesex, New Jersey, DOE/EA-0128, October 1980.
7. U.S. Department of Energy, Middlesex Sampling Plant and Middlesex Municipal Landfill Annual Site Environmental Report, Middlesex, New Jersey, Calendar Year 1985, DOE/OR/20722-97, August 1986.

8. U.S. Department of Energy, Project Report of Phase I Remedial Action of Properties Associated with the Former Middlesex Sampling Plant Site, Middlesex, New Jersey, NLCO-DOO6EV, April 1982.
9. Middlesex County Planning Board, Policies and Practices for Managing Middlesex County's Groundwater Resources, Middlesex, New Jersey, January 1979.
10. National Lead of Ohio, Inc., Environmental Assessment of the Properties Adjacent to and Nearby the Former Middlesex Sampling Plant, Middlesex, New Jersey, UC-342, October 1980.
11. Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey - Final Report, October 1980.
12. Oak Ridge National Laboratory, Radiological Surveys of Properties in the Middlesex, New Jersey Area, DOE/EV-0005/1 (Supplement), ORNL-5680, March 1981.
13. Oak Ridge National Laboratory: Radon and Radon Daughter Measurements at and Near the Former Middlesex Sampling Plant, Middlesex, New Jersey, ORNL-5489, March 1980.
14. Department of Energy, Radiological Survey Report for the Former Middlesex Sampling Plant, Middlesex, New Jersey, DOE/OR/20722-20, March 1985.

SITE INSPECTION
FOR
MIDDLESEX SAMPLING PLANT
MIDDLESEX, NEW JERSEY

JUNE 1989

Prepared for

UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE
Under Contract No. DE-AC05-81OR20722

By
J. H. Wright and D. J. Whiting

Bechtel National, Inc.
Oak Ridge, Tennessee

Bechtel Job No. 14501

TABLE OF CONTENTS

	<u>Page</u>
List of Figures	v
List of Tables	vii
Abbreviations	viii
Acronyms	ix
1.0 Introduction	1
2.0 Site Inspection Form	2
3.0 MSP Background	17
3.1 Site History	17
3.2 Owner History	23
4.0 Description of the Existing Environment	28
4.1 Climate	28
4.2 Ecology	31
4.3 Socioeconomic Factors	31
5.0 Geology	36
5.1 Topography	36
5.2 Geology and Soils	36
6.0 Hydrology	41
6.1 Surface Water	41
6.2 Groundwater	44
6.2.1 Shallow Groundwater	46
6.2.2 Bedrock Groundwater	51
7.0 Storage Pile Construction	53

8.0	Summary of Contamination	55
8.1	ORNL Survey	55
8.1.1	Soil Survey	55
8.1.2	Summary of ORNL Survey	55
8.2	Weston Survey	56
8.2.1	Subsurface Soil and Rock Survey	56
8.2.2	Groundwater Survey	64
8.2.3	Summary of Weston Survey	65
8.3	BNI Survey	65
8.3.1	Soil Survey	66
8.3.2	Process Building	75
8.3.3	Boiler House	80
8.3.4	Administration Building	80
8.3.5	Garage	81
8.4	Miscellaneous Environmental Monitoring	81
9.0	Remedial Action	92
10.0	Bibliography	96

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
3-1	Map of the MSP Site	20
3-2	Aerial View of the MSP, Looking South	21
3-3	Aerial View of MSP	22
3-4	MSP Site Location	24
3-5	Location of the MSP, MML, and Previously Contaminated Properties	25
3-6	Locations of Contaminated Properties Adjacent to and Near MSP	26
4-1	Location of Middlesex, New Jersey	29
4-2	Annual Wind Rose for MSP	30
4-3	Political Jurisdictions and Major Transportation Routes in the MSP Vicinity	32
4-4	Population Distribution Around MSP and MML	34
4-5	Generalized Land Uses in the Vicinity of MSP and MML	35
5-1	Former MSP Site Map	37
5-2	Generalized Geologic Section--Middlesex County	38
5-3	Groundwater Monitoring Wells at MSP	39
6-1	Major Drainage Basins--Middlesex County	42
6-2	Surface Water Sampling Locations and Drainage Near the MSP Site	43
6-3	Floodplains and Approximate Locations of Wells in Vicinity of MSP	45
6-4	MSP Groundwater Potentiometric Surface--Shallow Wells (3/28/88)	49

		<u>Page</u>
6-5	MSP Groundwater Potentiometric Surface--Deep Wells (3/24/88)	50
8-1	Correlation of Radium Concentration and Counts Per Minute	63
8-2	Borehole Locations at the Former MSP Site	67
8-3	Map of the Middlesex Phase II Remedial Action Properties	87
8-4	Radon (Terradex) and External Gamma Radiation Monitoring Locations at MSP	91
9-1	Storage Piles at the MSP Site	94

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
3-1	Volumes of Contaminated Soil in the MSP Storage Piles	19
6-1	Groundwater Elevations at the MSP Site, 1980	47
6-2	Daily Precipitation Recorded at Newark International Airport	48
8-1	MSP Remedial Decontamination Project Solid Sample Analysis Results	57
8-2	MSP Groundwater Quality Analysis	60
8-3	Gamma Spectrometry Analysis of Soil Samples from the Asphalt/Soil Interface	68
8-4	Gamma Spectrometry Analysis of MSP Soil Samples from Borings	73
8-5	Summary of Preremedial Action Building Measurement Results Former MSP	76
8-6	Radiochemical Analysis of MSP Subsurface Water Samples	82
8-7	PIC Readings at Selected MSP Locations	83
8-8	Average Annual Radon-222 Concentrations Measured at the MSP Site Boundary Using Terradex Monitors, 1982-1987	89
8-9	Radon-222 Concentrations Measured at MSP Using Terradex Monitors, 1987-1988	90
9-1	Excavated Volume of Contaminated Soil at MSP	93

ABBREVIATIONS

cm	centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
g	grams
gal	gallon
gpd	gallon per day
gpd/ft	gallons per day per foot
h	hour
ha	hectare
hpd	hours per day
in.	inch
km	kilometer
km/h	kilometers per hour
L	liter
Lpd/m	liters per day per meter
m	meter
m ³	cubic meter
mgd	million gallons per day
msl	mean sea level
μCi/mL	microcuries per milliliter
μR	microroentgen
μR/h	microroentgens per hour
mi	mile
mph	miles per hour
mm	millimeters
mrad	millirad
mrad/h	millirad per hour
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m ² /s	picocuries per square meter per second
s	second
yd	yard
yd ³	cubic yard

ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
DOE	Department of Energy
EPA	Environmental Protection Agency
GSA	General Services Administration
HRS	Hazard Ranking System
MSP	Middlesex Sampling Plant
MED	Manhattan Engineer District
MML	Middlesex Municipal Landfill
NLO	National Lead of Ohio
ORNL	Oak Ridge National Laboratory
PIC	pressurized ionization chamber
SI	Site Inspection

1.0 INTRODUCTION

This document presents the findings of the Site Inspection (SI) completed for the Middlesex Sampling Plant (MSP) in Middlesex, New Jersey, in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act.

This SI report was completed after review of the preremedial strategy issued by the U.S. Environmental Protection Agency (EPA) in the Office of Solid Waste and Emergency Response (OSWER) Directive 9345.2-01. As discussed in the strategy, upon completion of a Preliminary Assessment, a preliminary Hazard Ranking System (HRS) score for the site is calculated. If the preliminary HRS score is greater than 25, an SI is necessary for that site. The preliminary HRS calculated for MSP was 26.9; therefore, the SI was conducted.

An inspection of the site was not conducted immediately before the production of this document; however, several inspections were completed previously and provide substantial information about the site history, geology, and waste characteristics.

Section 2.0 of this report consists of the SI form required by EPA. Sections 3.0 through 9.0 contain additional information to supplement the SI form. A bibliography appears in Section 10.0.

2.0 SITE INSPECTION FORM

This section consists of the required EPA Form 2070-13, which has been completed for the MSP. Supplemental data, such as site ownership and history, description of existing environment, geological and hydrological information, storage pile construction, summaries of contamination surveys and environmental monitoring, and remedial action, are presented in greater detail in Sections 3.0 through 9.0.



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 1 - SITE LOCATION AND INSPECTION INFORMATION

I. IDENTIFICATION

01 STATE NJ 02 SITE NUMBER 0890090012

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)

Middlesex Sampling Plant

02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER

239 Mountain Avenue

03 CITY

Middlesex

04 STATE

NJ

05 ZIP CODE

08846

06 COUNTY

Middlesex

07 COUNTY CODE

23

08 CONG DIST

09 COORDINATES

LATITUDE
40 34 N

LONGITUDE
74 29 W

10 TYPE OF OWNERSHIP (Check one)

☐ A PRIVATE

☒ B. FEDERAL DOE

☐ C. STATE

☐ D. COUNTY

☐ E. MUNICIPAL

☐ G. UNKNOWN

III. INSPECTION INFORMATION

01 DATE OF INSPECTION

MONTH DAY YEAR
/ /

02 SITE STATUS

☐ ACTIVE

☒ INACTIVE

03 YEARS OF OPERATION

1943

1967

UNKNOWN

04 AGENCY PERFORMING INSPECTION (Check all that apply)

☐ A. EPA

☐ B. EPA CONTRACTOR

☐ C. MUNICIPAL

☐ D. MUNICIPAL CONTRACTOR

☐ E. STATE

☐ F. STATE CONTRACTOR

☐ G. OTHER

05 CHIEF INSPECTOR

06 TITLE

07 ORGANIZATION

08 TELEPHONE NO.

09 OTHER INSPECTORS

10 TITLE

11 ORGANIZATION

12 TELEPHONE NO.

13 SITE REPRESENTATIVES INTERVIEWED

14 TITLE

15 ADDRESS

16 TELEPHONE NO.

17 ACCESS GAINED BY

(Check one)

☐ PERMISSION

☐ WARRANT

18 TIME OF INSPECTION

19 WEATHER CONDITIONS

IV. INFORMATION AVAILABLE FROM

01 CONTACT

B. Walker, Acting Director

02 OF (Agency/Organization)

Department of Energy

03 TELEPHONE NO.

615 576-0948

04 PERSON RESPONSIBLE FOR SITE INSPECTION FORM

J. H. Wright

05 AGENCY

N/A

06 ORGANIZATION

Bechtel

National, Inc.

07 TELEPHONE NO.

(615)

482-1552

08 DATE

11, 10, 87

MONTH DAY YEAR



03 WASTE CHARACTERISTICS (Check all that apply)

I HIGHLY VOLATILE
J EXPLOSIVE
K REACTIVE
L INCOMPATIBLE
M NOT APPLICABLE

NO OF DRUMS

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE			
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

[illegible]

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS	uranium ore	999	FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

*Includes waste in piles only; does not include waste that may be buried on site for which an estimate is not available.



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE 02 SITE NUMBER
NJ 0890090012

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☐ A GROUNDWATER CONTAMINATION 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

Monitoring indicates no problems

01 ☐ B SURFACE WATER CONTAMINATION 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

Monitoring indicates no problems

01 ☒ C CONTAMINATION OF AIR 02 ☒ OBSERVED (DATE Section 8.0) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

See Section 4.0 and Section 8.0

01 ☐ D FIRE/EXPLOSIVE CONDITIONS 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

01 ☐ E DIRECT CONTACT 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

01 ☒ F CONTAMINATION OF SOIL 02 ☒ OBSERVED (DATE 1986) ☐ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: 9.6 (Acres) 04 NARRATIVE DESCRIPTION

Nearby properties have been remediated

01 ☐ G DRINKING WATER CONTAMINATION 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

01 ☐ H WORKER EXPOSURE/INJURY 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION

01 ☐ I POPULATION EXPOSURE/INJURY 02 ☐ OBSERVED (DATE _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED _____ 04 NARRATIVE DESCRIPTION



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION
PART 4 - PERMIT AND DESCRIPTIVE INFORMATION

I. IDENTIFICATION

01 STATE NJ 02 SITE NUMBER 0890090012

II. PERMIT INFORMATION

01 TYPE OF PERMIT ISSUED (Check all that apply)	02 PERMIT NUMBER	03 DATE ISSUED	04 EXPIRATION DATE	05 COMMENTS
<input type="checkbox"/> A NPDES				
<input type="checkbox"/> B UIC				
<input type="checkbox"/> C AIR				
<input type="checkbox"/> D RCRA				
<input type="checkbox"/> E RCRA INTERIM STATUS				
<input type="checkbox"/> F SPCC PLAN				
<input checked="" type="checkbox"/> G STATE (Specify) SPDES	0054836	4/7/86	7/7/86	
<input type="checkbox"/> H LOCAL (Specify)				
<input type="checkbox"/> I. OTHER (Specify)				
<input type="checkbox"/> J NONE				

III. SITE DESCRIPTION

01 STORAGE/DISPOSAL (Check all that apply)	02 AMOUNT	03 UNIT OF MEASURE	04 TREATMENT (Check all that apply)	05 OTHER
<input type="checkbox"/> A. SURFACE IMPOUNDMENT	~66,000	yd ³	<input type="checkbox"/> A. INCINERATION	<input checked="" type="checkbox"/> A. BUILDINGS ON SITE
<input checked="" type="checkbox"/> B. PILES			<input type="checkbox"/> B. UNDERGROUND INJECTION	4 on site
<input type="checkbox"/> C. DRUMS, ABOVE GROUND			<input type="checkbox"/> C. CHEMICAL/PHYSICAL	06 AREA OF SITE
<input type="checkbox"/> D. TANK, ABOVE GROUND			<input type="checkbox"/> D. BIOLOGICAL	9.6 (Acres)
<input type="checkbox"/> E. TANK, BELOW GROUND			<input type="checkbox"/> E. WASTE OIL PROCESSING	
<input type="checkbox"/> F. LANDFILL			<input type="checkbox"/> F. SOLVENT RECOVERY	
<input type="checkbox"/> G. LANDFARM			<input type="checkbox"/> G. OTHER RECYCLING/RECOVERY	
<input type="checkbox"/> H. OPEN DUMP			<input type="checkbox"/> H. OTHER (Specify)	
<input type="checkbox"/> I. OTHER (Specify)				

07 COMMENTS

Four buildings on site: Process Building, Garage, Administration Building, Boiler Room

IV. CONTAINMENT

01 CONTAINMENT OF WASTES (Check one)
☒ A. ADEQUATE, SECURE ☐ B. MODERATE ☐ C. INADEQUATE, POOR ☐ D. INSECURE, UNSOUND, DANGEROUS

02 DESCRIPTION OF DRUMS, DIKING, LINERS, BARRIERS, ETC.

See Section 7.0

V. ACCESSIBILITY

01 WASTE EASILY ACCESSIBLE ☐ YES ☒ NO

02 COMMENTS

A 2.1 m (7 ft.) chain-link fence surrounds the site

VI. SOURCES OF INFORMATION (Cite specific references e.g. site files, sample analysis, reports)

See Section 10.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 5 - WATER, DEMOGRAPHIC, AND ENVIRONMENTAL DATA

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 10890090012

II. DRINKING WATER SUPPLY

01 TYPE OF DRINKING SUPPLY (Check all applicable)			02 STATUS			03 DISTANCE TO SITE	
	SURFACE	WELL	ENDANGERED	AFFECTED	MONITORED	A	1.25 (mi)
COMMUNITY	A <input type="checkbox"/>	B <input checked="" type="checkbox"/>	A <input type="checkbox"/>	B <input type="checkbox"/>	C <input type="checkbox"/>	B	(mi)
NON-COMMUNITY	C <input type="checkbox"/>	D <input checked="" type="checkbox"/>	D <input type="checkbox"/>	E <input type="checkbox"/>	F <input type="checkbox"/>		

III. GROUNDWATER

01 GROUNDWATER USE IN VICINITY (Check one)				
<input checked="" type="checkbox"/> A. ONLY SOURCE FOR DRINKING COMMERCIAL INDUSTRIAL IRRIGATION (No other water sources available)				
<input type="checkbox"/> B. DRINKING (Other sources available)				
<input type="checkbox"/> C. COMMERCIAL, INDUSTRIAL, IRRIGATION (Limited other sources available)				
<input type="checkbox"/> D. NOT USED, UNUSEABLE				
02 POPULATION SERVED BY GROUND WATER 93-100%			03 DISTANCE TO NEAREST DRINKING WATER WELL <0.25 (mi)	
04 DEPTH TO GROUNDWATER 25 (ft)	05 DIRECTION OF GROUNDWATER FLOW Southeast	06 DEPTH TO AQUIFER OF CONCERN 25 (ft)	07 POTENTIAL YIELD OF AQUIFER 100,000 (gpd)	08 SOLE SOURCE AQUIFER <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
09 DESCRIPTION OF WELLS (including usage, depth, and location relative to population and buildings)				
10 RECHARGE AREA <input type="checkbox"/> YES <input type="checkbox"/> NO		11 DISCHARGE AREA <input type="checkbox"/> YES <input type="checkbox"/> NO		
COMMENTS		COMMENTS		

IV. SURFACE WATER

01 SURFACE WATER USE (Check one)	
<input type="checkbox"/> A. RESERVOIR, RECREATION, DRINKING WATER SOURCE	
<input type="checkbox"/> B. IRRIGATION, ECONOMICALLY IMPORTANT RESOURCES	
<input checked="" type="checkbox"/> C. COMMERCIAL, INDUSTRIAL	
<input type="checkbox"/> D. NOT CURRENTLY USED	
02 AFFECTED/POTENTIALLY AFFECTED BODIES OF WATER	
NAME:	AFFECTED DISTANCE TO SITE
See Section 6.0	(mi)
	(mi)
	(mi)

V. DEMOGRAPHIC AND PROPERTY INFORMATION

01 TOTAL POPULATION WITHIN			02 DISTANCE TO NEAREST POPULATION
ONE (1) MILE OF SITE A. 16,000 NO. OF PERSONS	TWO (2) MILES OF SITE B. NO. OF PERSONS	THREE (3) MILES OF SITE C. NO. OF PERSONS	immediately off site (mi)
03 NUMBER OF BUILDINGS WITHIN TWO (2) MILES OF SITE		04 DISTANCE TO NEAREST OFF-SITE BUILDING (mi)	
05 POPULATION WITHIN VICINITY OF SITE (Provide narrative description of nature of population within vicinity of site, e.g., rural village, densely populated urban area)			
See Section 4.0			



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 5 - WATER, DEMOGRAPHIC, AND ENVIRONMENTAL DATA

I. IDENTIFICATION
01 STATE 02 SITE NUMBER
NJ 0890090012

VI. ENVIRONMENTAL INFORMATION

01 PERMEABILITY OF UNSATURATED ZONE: Check one

☐ A $10^{-6} - 10^{-8}$ cm/sec ☒ B $10^{-4} - 10^{-6}$ cm/sec ☐ C $10^{-2} - 10^{-4}$ cm/sec ☐ D GREATER THAN 10^{-2} cm/sec

02 PERMEABILITY OF BEDROCK: Check one: *

☐ A IMPERMEABLE (Less than 10^{-6} cm/sec) ☐ B RELATIVELY IMPERMEABLE ($10^{-4} - 10^{-6}$ cm/sec) ☐ C RELATIVELY PERMEABLE ($10^{-2} - 10^{-4}$ cm/sec) ☐ D VERY PERMEABLE (Greater than 10^{-2} cm/sec)

03 DEPTH TO BEDROCK

3 - 7.5 (ft)

04 DEPTH OF CONTAMINATED SOIL ZONE

N/A (ft)

05 SOIL pH

06 NET PRECIPITATION

12.53 (in)

07 ONE YEAR 24 HOUR RAINFALL

2.75 (in)

08 SLOPE
SITE SLOPE

1 %

DIRECTION OF SITE SLOPE

South

TERRAIN AVERAGE SLOPE

%

09 FLOOD POTENTIAL

SITE IS IN N/A YEAR FLOODPLAIN

10

☐ SITE IS ON BARRIER ISLAND, COASTAL HIGH HAZARD AREA, RIVERINE FLOODWAY

11 DISTANCE TO WETLANDS (5 acre minimum)

ESTUARINE

OTHER

A N/A (mi)

B N/A (mi)

12 DISTANCE TO CRITICAL HABITAT (of endangered species)

N/A (mi)

ENDANGERED SPECIES

13 LAND USE IN VICINITY

DISTANCE TO See Section 4.0

COMMERCIAL/INDUSTRIAL

RESIDENTIAL AREAS, NATIONAL/STATE PARKS,
FORESTS, OR WILDLIFE RESERVES

AGRICULTURAL LANDS
PRIME AG LAND AG LAND

A. (mi)

B. (mi)

C. (mi)

D. (mi)

14 DESCRIPTION OF SITE IN RELATION TO SURROUNDING TOPOGRAPHY

See Section 4.0, 5.0 and 6.0

*Permeabilities for the bedrock are not available at this time.

VII. SOURCES OF INFORMATION (Cite specific references e.g., state files, sample analysis, reports)

See Section 10.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 6 - SAMPLE AND FIELD INFORMATION

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 0890090012

II. SAMPLES TAKEN See Section 8.0

SAMPLE TYPE	01 NUMBER OF SAMPLES TAKEN	02 SAMPLES SENT TO	03 ESTIMATED DATE RESULTS AVAILABLE
GROUNDWATER			
SURFACE WATER			
WASTE			
AIR			
RUNOFF			
SPILL			
SOIL			
VEGETATION			
OTHER			

III. FIELD MEASUREMENTS TAKEN See Section 8.0

01 TYPE	02 COMMENTS

IV. PHOTOGRAPHS AND MAPS

01 TYPE <input type="checkbox"/> GROUND <input checked="" type="checkbox"/> AERIAL	02 IN CUSTODY OF <u>DOE</u> <small>(Name of organization or individual)</small>
03 MAPS <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	04 LOCATION OF MAPS <u>Figures throughout document.</u>

V. OTHER FIELD DATA COLLECTED (Provide narrative description)

See Section 8.0

VI. SOURCES OF INFORMATION (Cite specific references e.g. state files, sample analysis reports)

See Section 10.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 7 - OWNER INFORMATION

L IDENTIFICATION
01 STATE 02 SITE NUMBER
NJ 0890090012

II. CURRENT OWNER(S)				PARENT COMPANY (if appropriate)			
01 NAME		02 D+8 NUMBER		06 NAME		08 D+8 NUMBER	
DOE, OR Operations							
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, APO F, etc.)		11 SIC CODE	
P.O. Box 2001							
06 CITY		08 STATE	07 ZIP CODE	12 CITY		13 STATE	14 ZIP CODE
Oak Ridge		TN	37831				
01 NAME		02 D+8 NUMBER		06 NAME		08 D+8 NUMBER	
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, APO F, etc.)		11 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	12 CITY		13 STATE	14 ZIP CODE
01 NAME		02 D+8 NUMBER		06 NAME		08 D+8 NUMBER	
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, APO F, etc.)		11 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	12 CITY		13 STATE	14 ZIP CODE
01 NAME		02 D+8 NUMBER		06 NAME		08 D+8 NUMBER	
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, APO F, etc.)		11 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	12 CITY		13 STATE	14 ZIP CODE
III. PREVIOUS OWNER(S) (List from Form 8700)				IV. REALTY OWNER(S) (if appropriate: list from Form 8700)			
01 NAME		02 D+8 NUMBER		01 NAME		02 D+8 NUMBER	
Department of Navy							
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	06 CITY		08 STATE	07 ZIP CODE
01 NAME		02 D+8 NUMBER		01 NAME		02 D+8 NUMBER	
Atomic Energy Commission							
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	06 CITY		08 STATE	07 ZIP CODE
01 NAME		02 D+8 NUMBER		01 NAME		02 D+8 NUMBER	
03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, APO F, etc.)		04 SIC CODE	
06 CITY		08 STATE	07 ZIP CODE	06 CITY		08 STATE	07 ZIP CODE
V. SOURCES OF INFORMATION (City, County, Township, etc., State, etc., County, etc., etc.)							
See Section 10.0							

EPA FORM 2070-13 (7-81)



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 8 - OPERATOR INFORMATION

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 0890090012

II. CURRENT OPERATOR (Provide if different from owner)

OPERATOR'S PARENT COMPANY (If applicable)

01 NAME DOE, OR Operations		02 D+B NUMBER		10 NAME		11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.) P.O. Box 2001		04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)		13 SIC CODE	
05 CITY Oak Ridge		06 STATE TN	07 ZIP CODE 37831	14 CITY		15 STATE	16 ZIP CODE
08 YEARS OF OPERATION 1980-Present		09 NAME OF OWNER DOE					

III. PREVIOUS OPERATOR(S) (List most recent first; provide only if different from owner)

PREVIOUS OPERATORS' PARENT COMPANIES (If applicable)

01 NAME 6th Motor Transport Battalion Reserve		02 D+B NUMBER		10 NAME		11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)		13 SIC CODE	
05 CITY		06 STATE	07 ZIP CODE	14 CITY		15 STATE	16 ZIP CODE
08 YEARS OF OPERATION 1969 - 79		09 NAME OF OWNER DURING THIS PERIOD Department of Navy					
01 NAME United Lead Company		02 D+B NUMBER		10 NAME		11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)		13 SIC CODE	
05 CITY		06 STATE	07 ZIP CODE	14 CITY		15 STATE	16 ZIP CODE
08 YEARS OF OPERATION 1943 - 55		09 NAME OF OWNER DURING THIS PERIOD Atomic Energy Commission					
01 NAME		02 D+B NUMBER		10 NAME		11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)		13 SIC CODE	
05 CITY		06 STATE	07 ZIP CODE	14 CITY		15 STATE	16 ZIP CODE
08 YEARS OF OPERATION		09 NAME OF OWNER DURING THIS PERIOD					

IV. SOURCES OF INFORMATION (Cite specific references, e.g., State files, sample analyses, reports)

See Section 10.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 9 - GENERATOR/TRANSPORTER INFORMATION

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 0890090012

II. ON-SITE GENERATOR

01 NAME See Section 3.0--Same as owners and operators (except U.S. Navy, which was not a generator).

03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE
05 CITY	06 STATE	07 ZIP CODE

III. OFF-SITE GENERATOR(S)

01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
None							
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	
01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	

IV. TRANSPORTER(S)

01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	
01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	

V. SOURCES OF INFORMATION (Cite specific references e.g. State Reg. Sample Analysis Reports)

See Section 10.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 10 - PAST RESPONSE ACTIVITIES

I. IDENTIFICATION

01 STATE 02 SITE NUMBER
NJ 0890090012

II. PAST RESPONSE ACTIVITIES

01 <input type="checkbox"/> A. WATER SUPPLY CLOSED 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> B. TEMPORARY WATER SUPPLY PROVIDED 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> C. PERMANENT WATER SUPPLY PROVIDED 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> D. SPILLED MATERIAL REMOVED 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input checked="" type="checkbox"/> E. CONTAMINATED SOIL REMOVED 04 DESCRIPTION See Section 9.0	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> F. WASTE REPACKAGED 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> G. WASTE DISPOSED ELSEWHERE 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input checked="" type="checkbox"/> H. ON SITE BURIAL storage 04 DESCRIPTION Waste stored on site in piles (covered and lined) and in buildings.	02 DATE *	03 AGENCY _____
01 <input type="checkbox"/> I. IN SITU CHEMICAL TREATMENT 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> J. IN SITU BIOLOGICAL TREATMENT 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> K. IN SITU PHYSICAL TREATMENT 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> L. ENCAPSULATION 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> M. EMERGENCY WASTE TREATMENT 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> N. CUTOFF WALLS 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> O. EMERGENCY DIKING/SURFACE WATER DIVERSION 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> P. CUTOFF TRENCHES/SUMP 04 DESCRIPTION	02 DATE _____	03 AGENCY _____
01 <input type="checkbox"/> Q. SUBSURFACE CUTOFF WALL 04 DESCRIPTION	02 DATE _____	03 AGENCY _____

*See Section 7.0, 8.0, and 9.0



POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 11 - ENFORCEMENT INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
NJ	0890090012

II. ENFORCEMENT INFORMATION

01 PAST REGULATORY/ENFORCEMENT ACTION YES NO X (None indicated in files reviewed)

02 DESCRIPTION OF FEDERAL, STATE, LOCAL REGULATORY ENFORCEMENT ACTION

I. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis reports)

See Section 10.0

FORM 2070-13 (7-81)

3.0 MSP BACKGROUND

3.1 SITE HISTORY

The Manhattan Engineer District (MED) established MSP in 1943. The facility was used for the sampling, storage, and shipment of uranium, thorium, and beryllium ores. The uranium operations were conducted under contract with United Lead Company between November 1943 and February 1955 and involved most of the ore and compounds received from the African Metals Company. All ores received at the facility were handled in a similar manner, including thawing (if necessary), drying, crushing, and screening. Samples were taken for assay from collection hoppers beneath screens. The ores were subsequently packaged, weighed, and shipped to processing facilities.

The site received and shipped various research-related and decontamination wastes. Low-level combustible waste was incinerated on the site, and the ashes were placed in drums and sent with the noncombustible waste and scrap for ocean disposal.

During 1951 and 1952, MSP became the transshipment point for uranium bars shipped from the Lake Ontario Ordinance Works to the American Machine and Foundry Company in Brooklyn, New York, where the bars were experimentally machined into slugs. Scrap from this operation was returned to Middlesex to be shipped to a processor for uranium recovery.

Operation of MSP was terminated in 1955 by the Atomic Energy Commission (AEC), successor to MED. Prior to closing in February 1955, the site was also processing beryllium ore for shipment to Brush Beryllium in Luckey, Ohio. The site continued to be used as a thorium materials storage site until AEC operations terminated in September 1967, at which time the site was decontaminated by Isotopes, Inc. On-site structures were decontaminated, and the site was certified with no radiological restrictions under criteria in effect at that time.

In 1968, AEC returned the MSP site to the General Services Administration (GSA), which transferred the property to the U.S. Department of the Navy. The site served as a reserve training center for the U.S. Marine Corps from 1969 to 1979. MSP was returned to the U.S. Department of Energy (DOE) in 1980. That same year, DOE initiated remedial action to clean up properties in the vicinity of MSP, with the cleanup continuing into 1981. Approximately 26,600 m³ (35,000 yd³) of contaminated soil from this remedial action was transported to MSP, where an asphalt pad was constructed as a base for an interim storage pile.

Excavation of radioactively contaminated materials from the Middlesex Municipal Landfill (MML) was initiated in 1984, and approximately 11,500 m³ (15,000 yd³) of contaminated soil was transported to MSP for interim storage.

A second storage pile was constructed at MSP in 1984 to accommodate the materials excavated from MML. The storage pile was extended again in 1986, and the stockpile height was increased to accept the material excavated from the MML during that year. The piles were enclosed with concrete curbing to prevent migration of the stored materials. Synthetic geomembrane fabric was attached to the curbing to cover the stored materials when remedial action was not in progress. Table 3-1 shows the total volume of contaminated materials presently stored at MSP, including the source of the materials and when they were emplaced.

The MSP site occupies 9.6 acres (3.9 ha), 8 of which were paved with asphalt to provide a drum-storage area. As shown in Figure 3-1, four buildings remain on the site; an administration building, a garage, a process building, and a boiler house. The site is surrounded by a 2.1 m (7 ft) chain-link fence. MSP is currently used for interim storage of contaminated soil excavated from vicinity properties, including MML. Figure 3-2 is a 1983 aerial photograph of the site; Figure 3-3 is an aerial photograph of the site taken after the 1986 remedial action. At the completion of the 1986 remedial action, approximately 50,600 m³ (66,200 yd³) of

TABLE 3-1
VOLUMES OF CONTAMINATED SOIL
IN THE MSP STORAGE PILES

Date and Source	Volume	
	(m ³)	(yd ³)
1980 (Phase I) MSP Cleanup	7,203	9,421
1981 (Phase II) MSP Cleanup	19,681	25,742
1984 MML Cleanup (Separate Storage Pile)	11,468	15,000
1986 MML Cleanup (Extended Second Storage Pad)	<u>12,233</u>	<u>16,000</u>
TOTAL	50,585	66,163

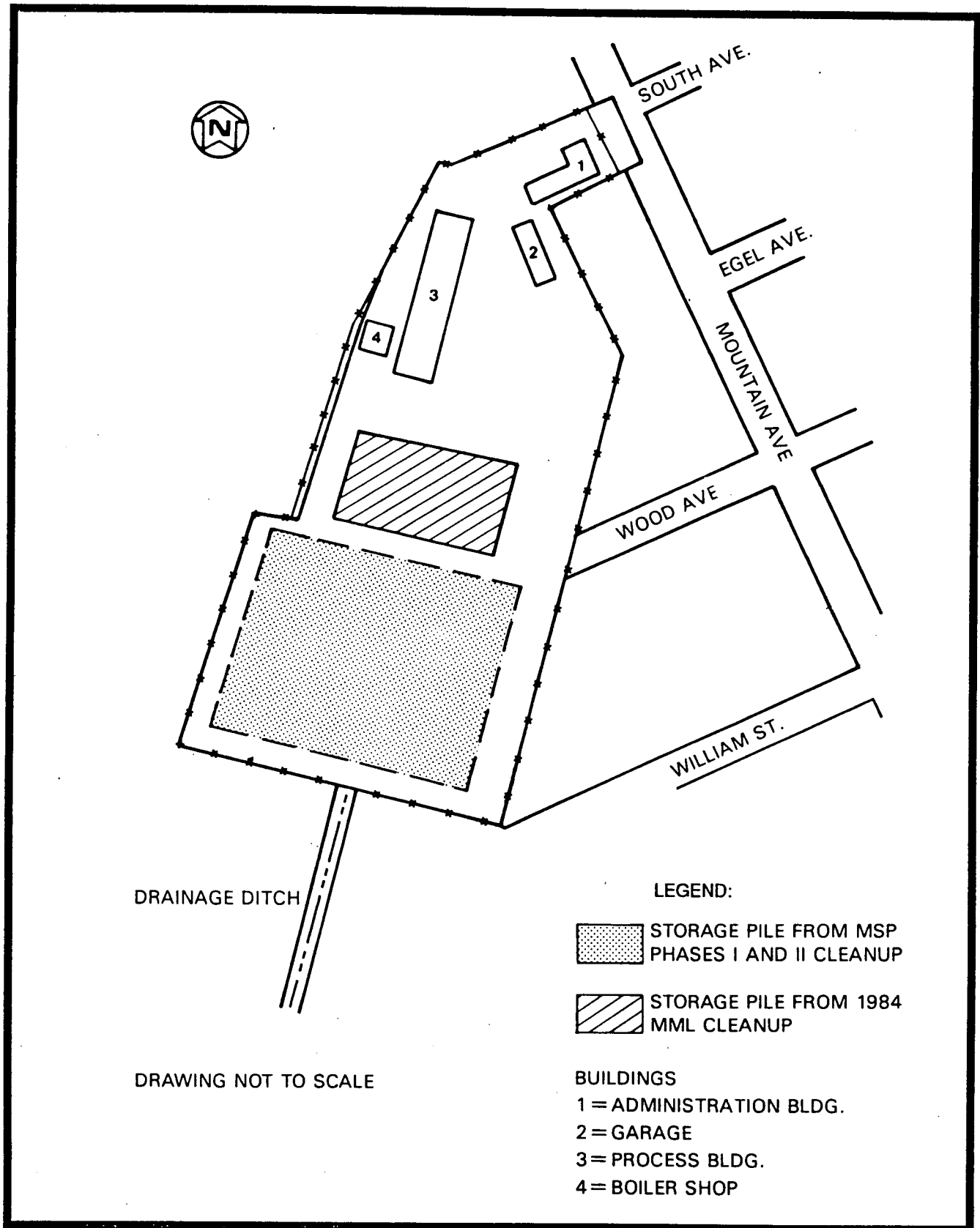


FIGURE 3-1 MAP OF THE MSP SITE

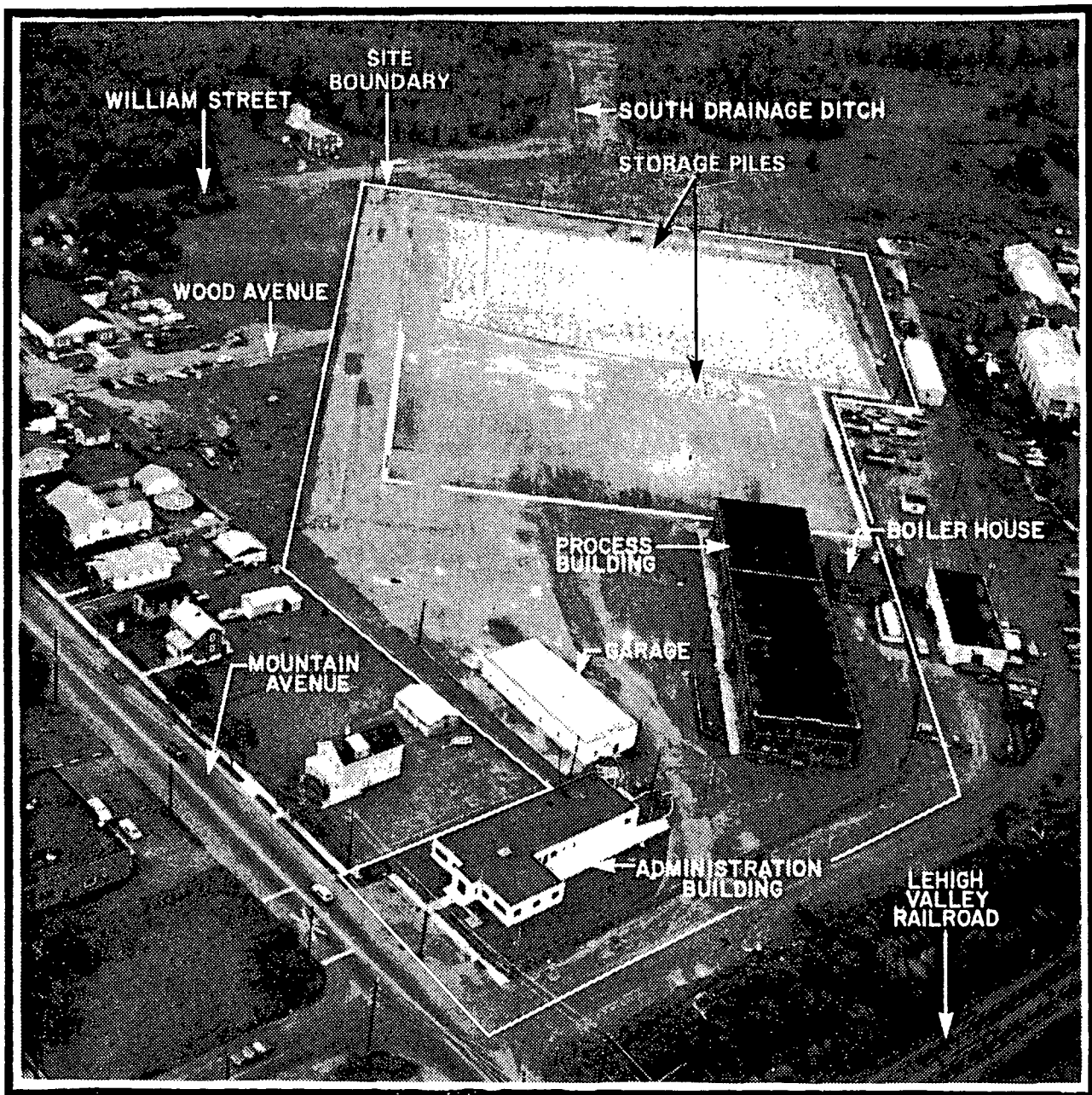


FIGURE 3-2 AERIAL VIEW OF THE MSP, LOOKING SOUTH

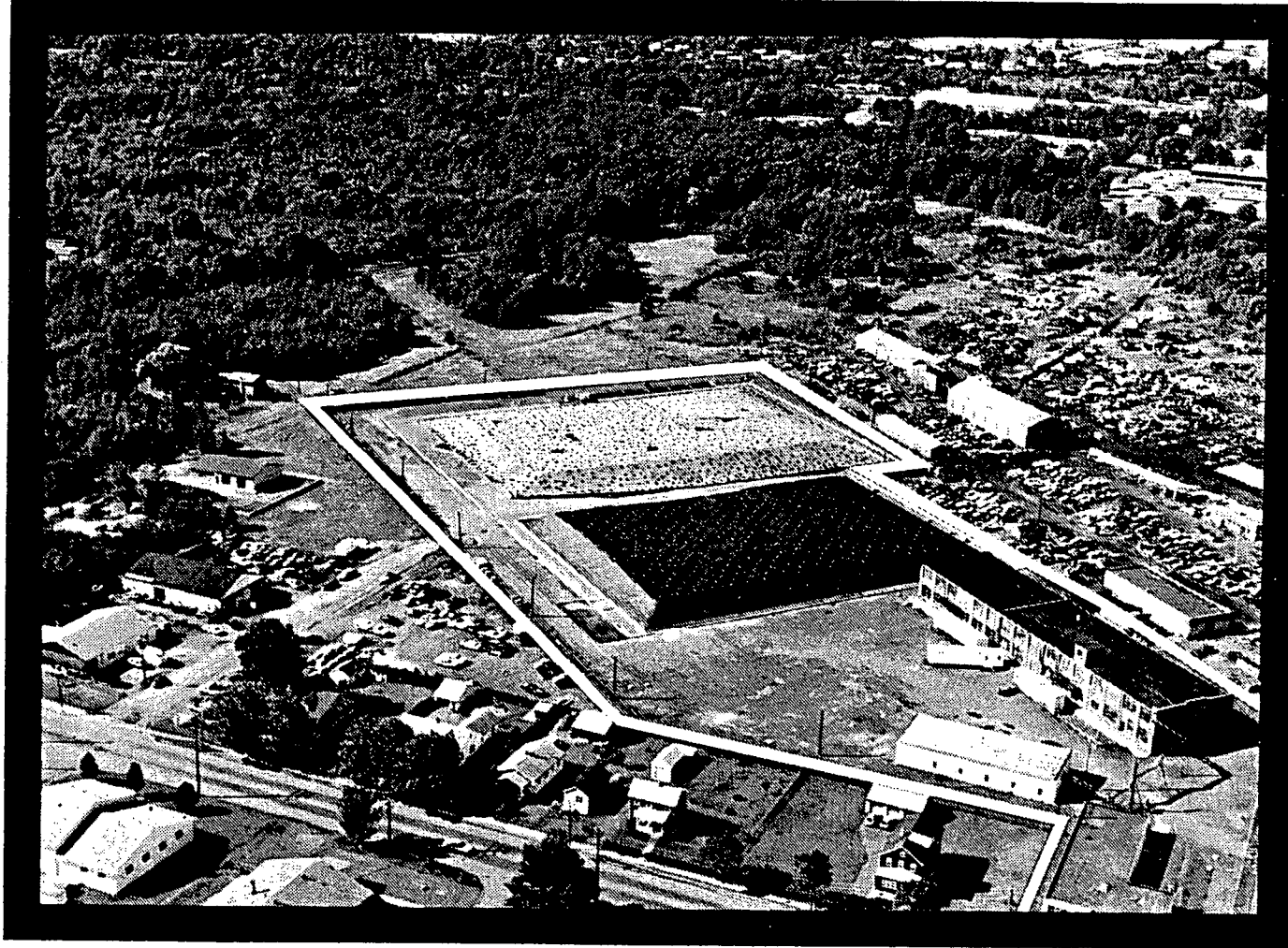


FIGURE 3-3 AERIAL VIEW OF MSP

contaminated soil was stored at MSP. The design of the interim storage pile at the site includes a leachate collection system to preclude the uncontrolled release of contaminants.

The east side of the facility borders on fields and garden areas. The west side borders an industrial site. The property to the south consists of marshy land and fields. The main entrance to the facility (Mountain Avenue) is on the north side. The north side also borders the Lehigh Valley Railroad right-of-way property. Figure 3-4 shows the location of the site in Middlesex.

The soil of some portions of the adjacent and nearby properties (Figures 3-5 and 3-6), especially along the south border, once contained residual radioactive material. Two nonadjacent private properties were also identified as having soil contaminated with radioactive ore from the former MSP. These properties were remediated in 1981 and 1982.

3.2 OWNER HISTORY

At the request of MED, the North Atlantic Division Engineers leased the first portion of the MSP property from American Marietta Company on November 1, 1943. Supplements to the lease were issued on May 15, 1945, and June 27, 1945, to include additional properties. Another lease was executed with private owners of nearby property to expand the storage area of the site and obtain easements. Procedures for government purchase of the property were initiated on March 8, 1946, and procurement was authorized by the Secretary of War on June 20, 1946. Because the owners would not sell willingly at the appraised value of the property, a Petition in Condemnation and a Declaration of Taking were filed on September 12, 1947, and the leases were thereby cancelled. A Judgment on Stipulation, filed on June 15, 1957, gave AEC title to the property for an acceptable price. Easement agreements for drainage across the properties south of the site were also obtained by AEC.

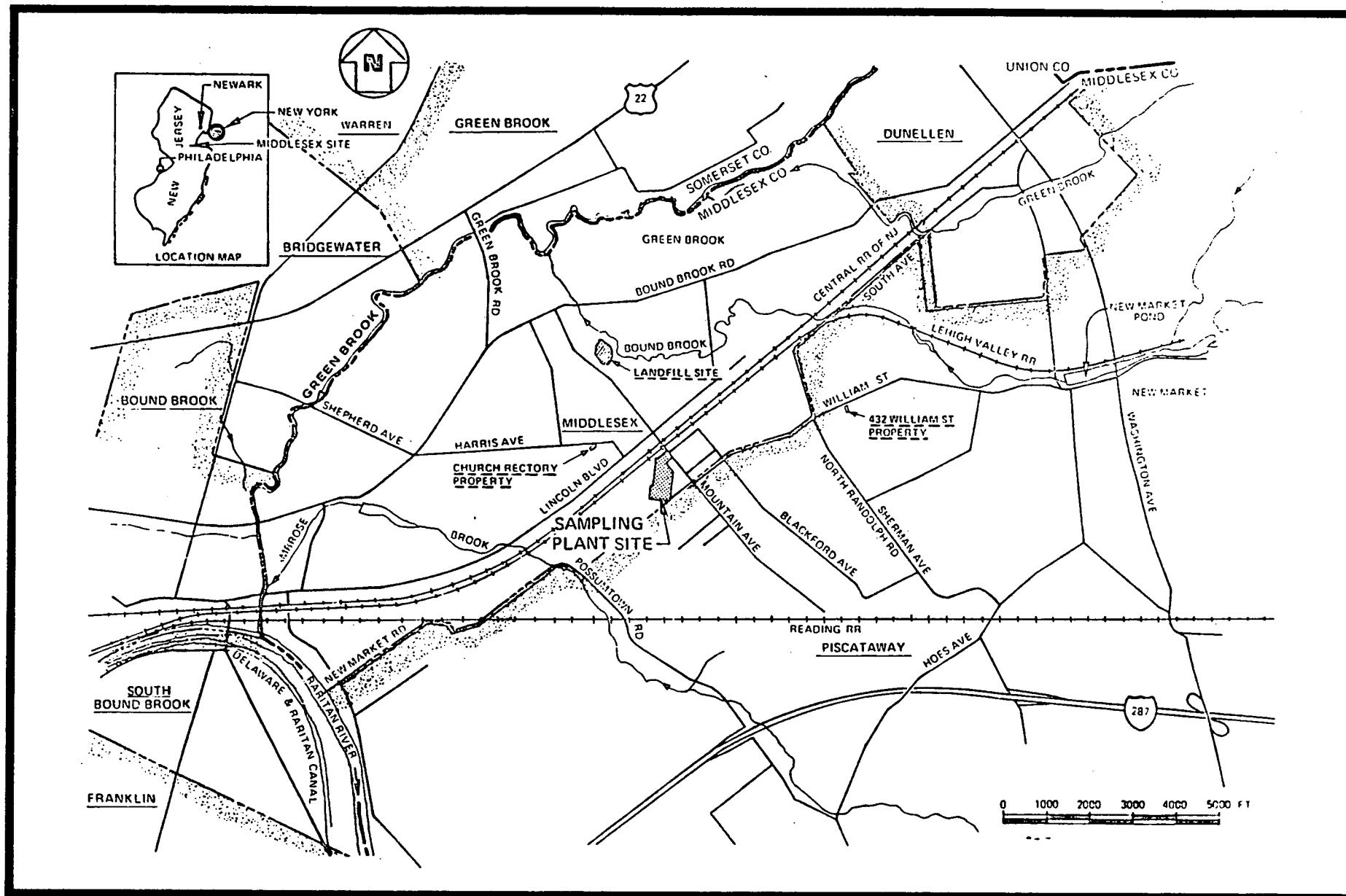


FIGURE 3-4 MSP SITE LOCATION

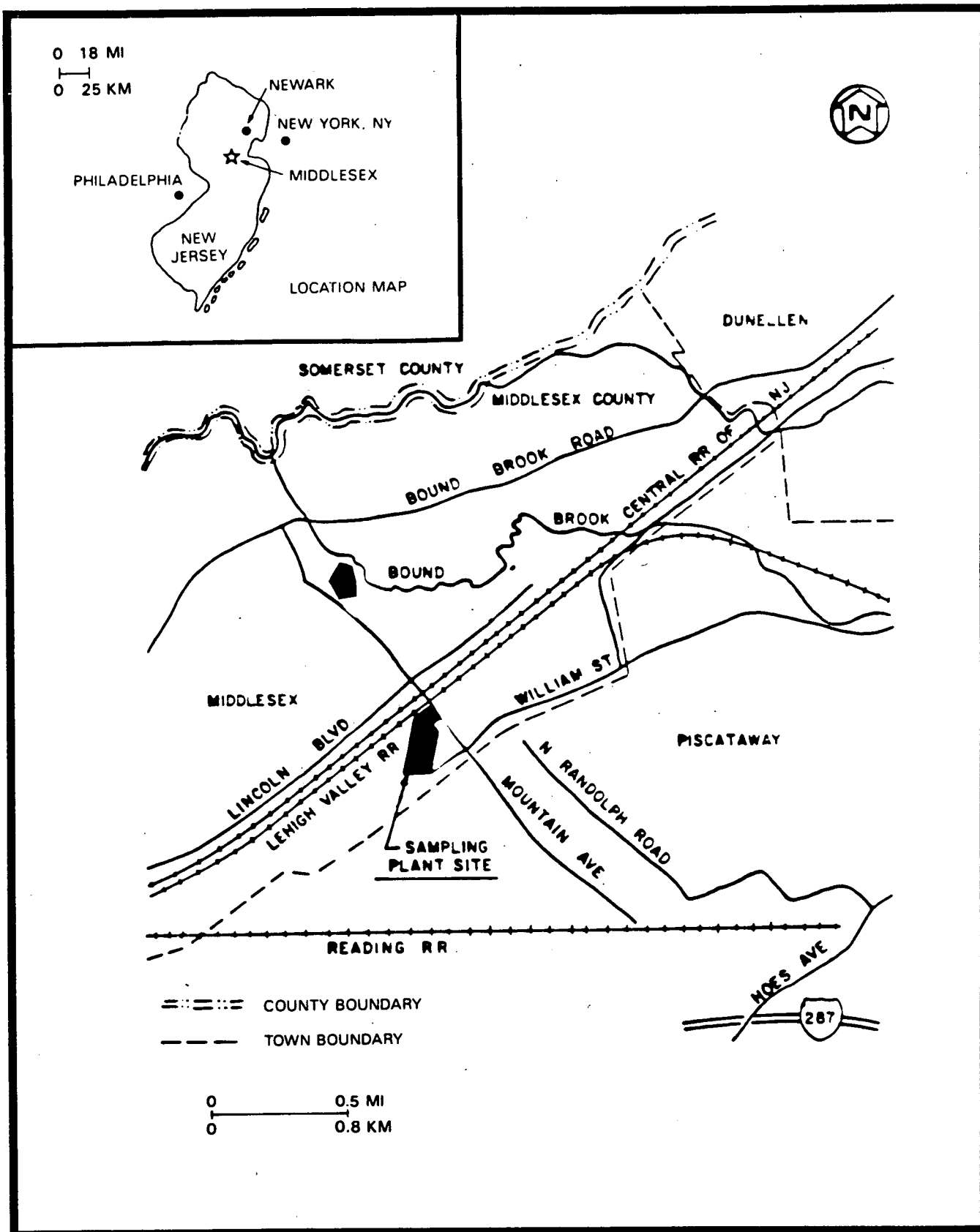


FIGURE 3-5. LOCATION OF THE MSP, MML, AND PREVIOUSLY CONTAMINATED PROPERTIES

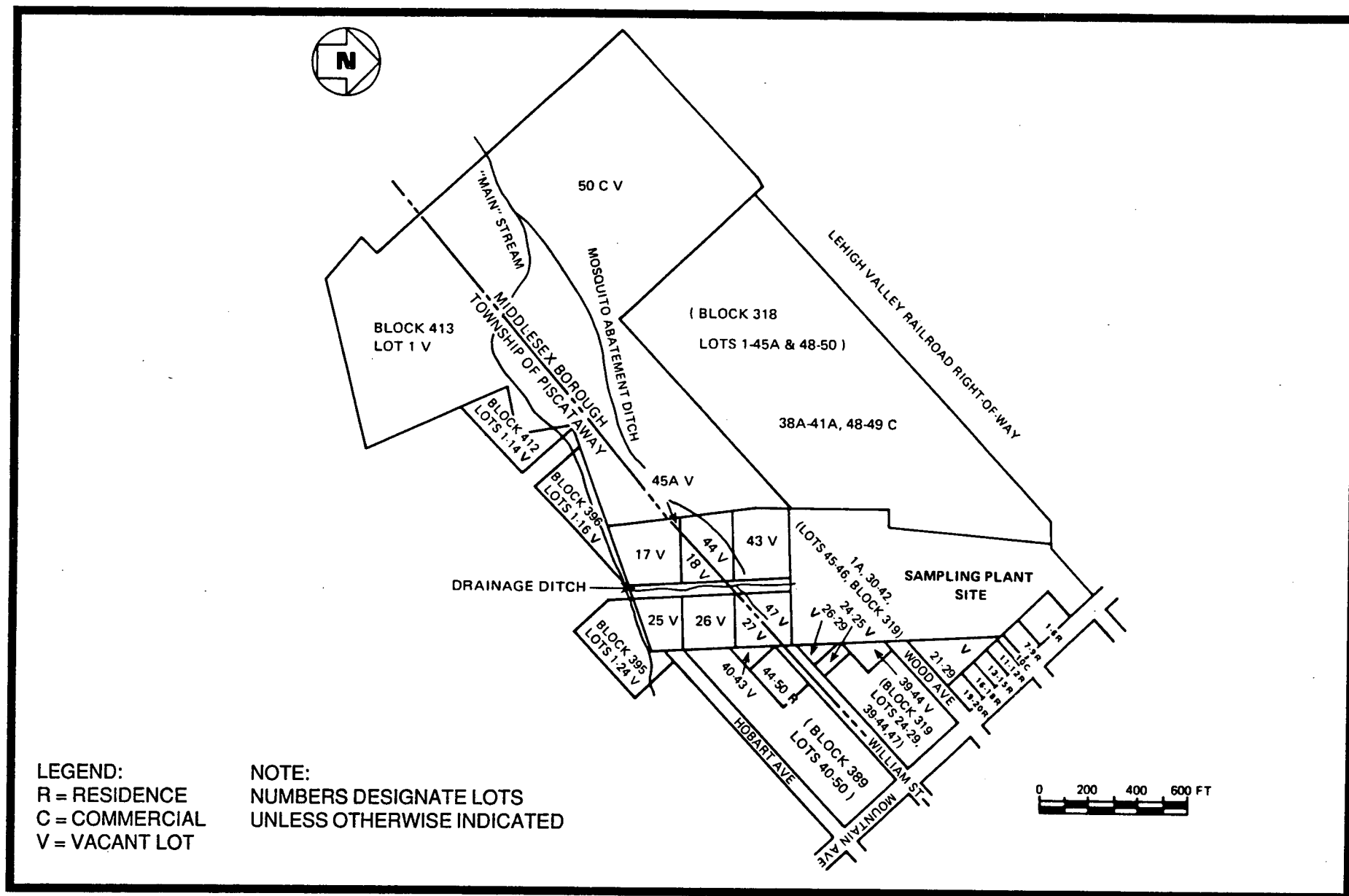


FIGURE 3-6 LOCATIONS OF CONTAMINATED PROPERTIES ADJACENT TO AND NEAR MSP

The site was operated by United Lead Company for AEC until the site closed in 1955. Lucius Pitkin conducted the thorium storage operations on the site after 1955.

On February 22, 1968, AEC officially reported the property as excess real property. On January 3, 1969, GSA transferred the property to the U.S. Department of the Navy, U.S. Marine Corps. The U.S. Marine Corps used the property for the 6th Motor Transport Battalion Reserve Training. Through an agreement established in 1980, DOE agreed to be custodian of the site and contracted with National Lead of Ohio, Inc. (NLO) to maintain it. In 1981, Bechtel National, Inc. (BNI), replaced NLO as the project management contractor for remedial actions.

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

Middlesex, New Jersey, is located in an urban area about 35 km (22 mi) southwest of downtown Manhattan (New York City), 24 km (15 mi) southwest of Newark, New Jersey, and 48 km (30 mi) northeast of Trenton, New Jersey (Figure 4-1).

4.1 CLIMATE

MSP is approximately 4.8 km (3 mi) from a National Weather Service precipitation station at Bound Brook, 8.1 km (5 mi) from a precipitation and temperature station at Plainfield, and 29.0 km (18 mi) from a full-weather station at the Newark, New Jersey, airport. The following information was obtained from those stations where weather data have been collected from 1941 to 1976.

The average annual daily maximum temperature is 16.9°C (62.5°F), with average daily minimums of 7.3°C (45.2°F). Average highs occur in July with readings of 29.8°C (85.6°F), and average lows of -4.3°C (24.3°F) occur in January. Temperature decreases of from -15 to -9.4°C (5° to 15°F) are not uncommon when the winds shift from the southwest to the southeast.

Average annual snowfall is 0.7 m (27.5 in.). A low of 4.8 cm (1.9 in.) occurred in 1972, and a high of 1.9 m (73.5 in.) occurred in 1960. Average annual total precipitation is 1.1 m (41.64 in.), with a low of 0.7 m (26.09 in.) occurring in 1965 and a high of 1.4 m (53.3 in.) in 1952.

Winds are predominately from the southwest at a mean speed of 16.4 km/h (10.2 mph). During January, the winds are from the northeast at 17.9 km/h (11.1 mph). April is the transition month when the winds come from the west-northwest at 18.2 km/h (11.3 mph). During the remainder of the months, the winds are primarily from the southwest. A wind rose for the area is shown in Figure 4-2.

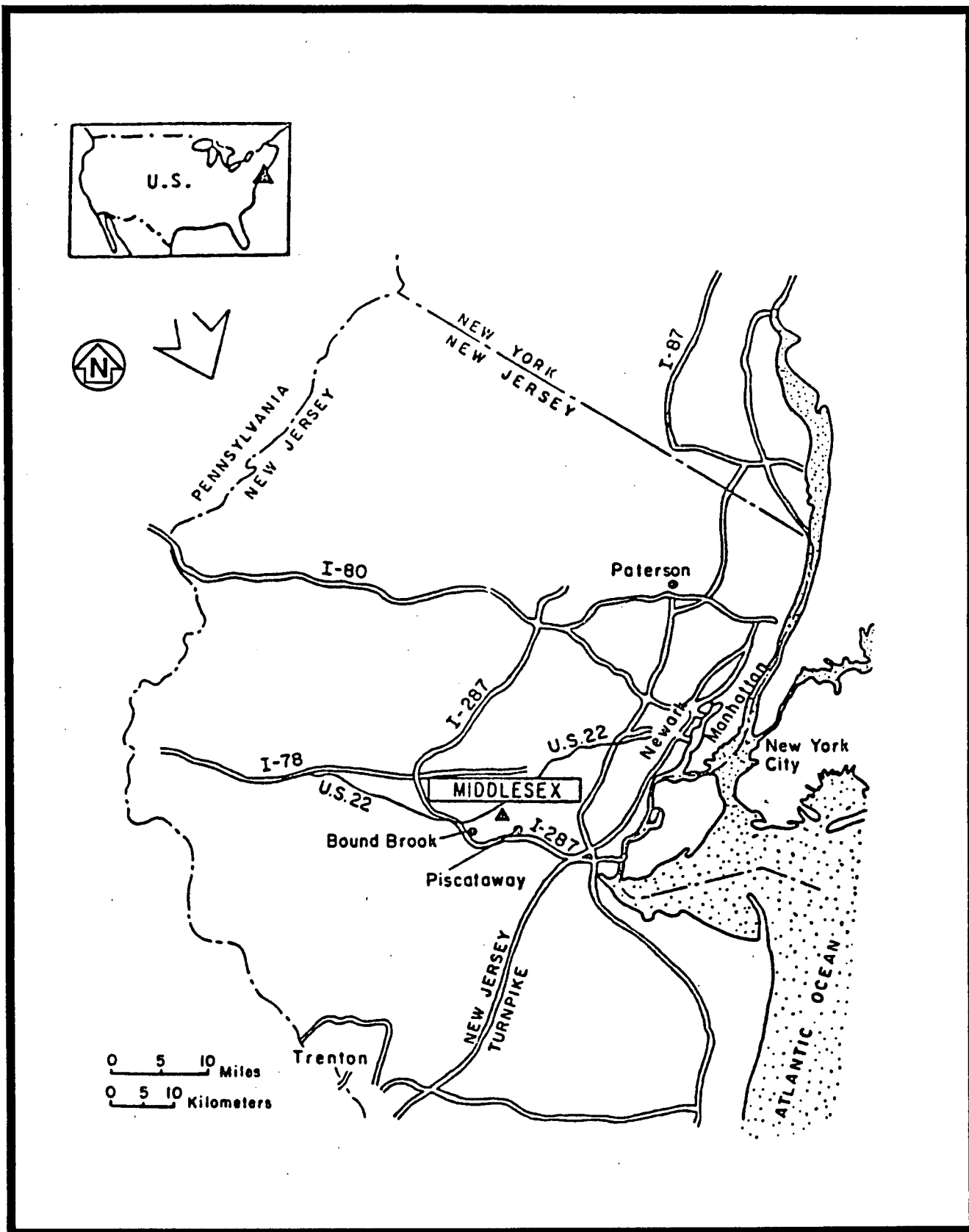
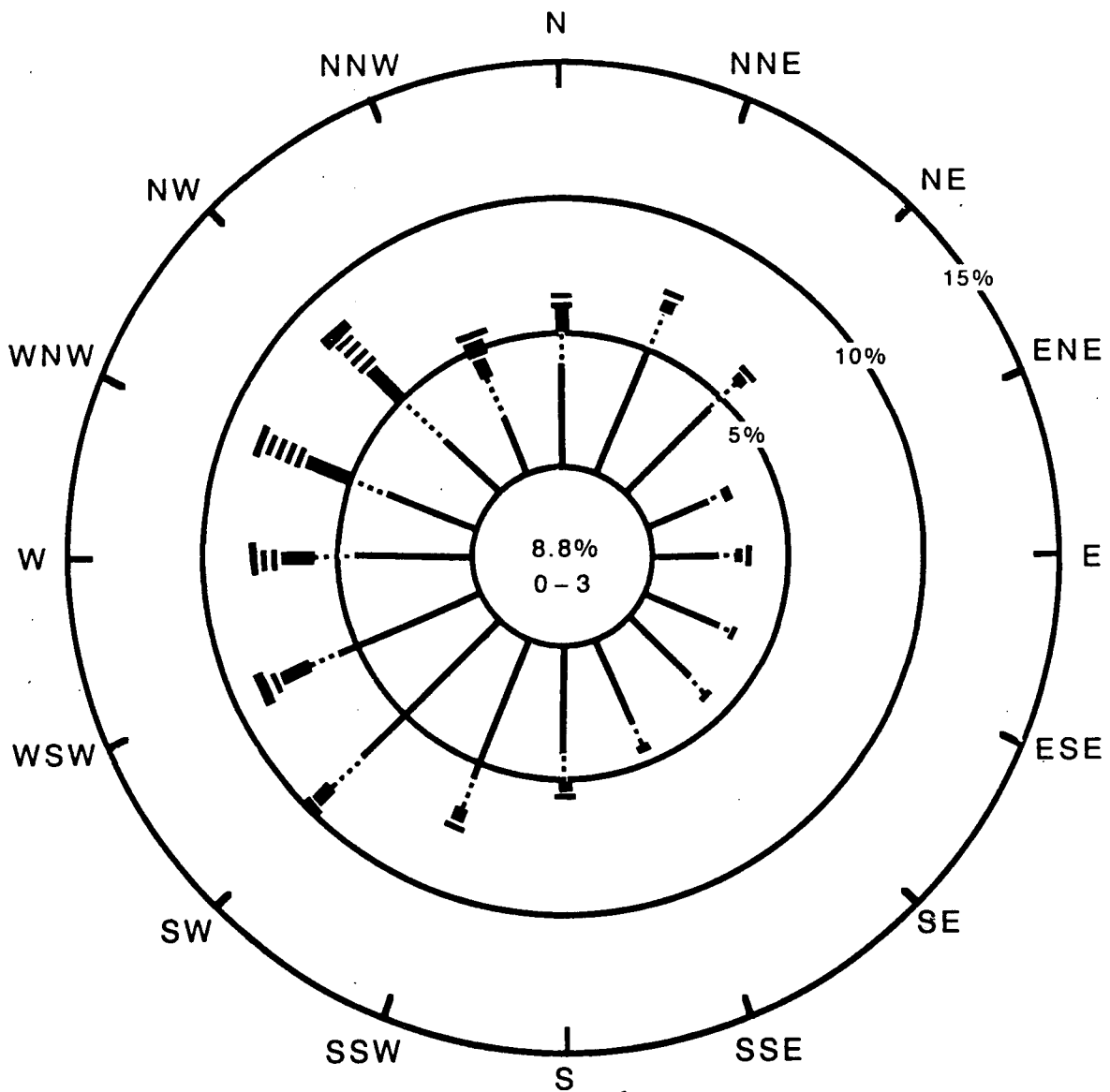


FIGURE 4-1 LOCATION OF MIDDLESEX, NEW JERSEY



NOTE: BASED ON DATA FROM THE NEWARK AIRPORT WEATHER STATION (LOCATED 19 MI FROM MIDDLESEX) FOR THE PERIOD 1948 - 1978.

FIGURE 4-2 ANNUAL WIND ROSE FOR MSP

The average sea level barometric pressure is 762.5 mm (30.02 in.), with extremes of 787.7 mm (31.01 in.) and 728.7 mm (28.69 in.).

4.2 ECOLOGY

Grasses, weeds, and small shrubs form a habitat for birds and small mammals. No rare or endangered species of flora or fauna are known to exist within the environs of the site.

Middlesex is located within the glaciated area of the Appalachian Oak Forest section of the eastern deciduous forest. This forest section is characterized by oak, hickory, maple, basswood, elm, and ash--with alder, willow, ash, elm and hygrophytic shrubs common in moist or poorly drained habitats.

A lack of suitable habitat probably limits the fauna. Commonly encountered species are those that have adapted to suburban/urban encroachment. Birds include the house sparrow, starling, rock dove, red-winged blackbird, common crow, and robin. Mammals include the Norway rat, raccoon, opossum, woodchuck, house mouse, meadow vole, white-footed mouse, deer mouse, eastern mole, eastern cottontail rabbit, striped skunk, eastern gray squirrel, and shorttail shrew. A few species of reptiles, such as the eastern garter snake and American toad, have partially adapted to urban habitats and can be expected to occur in the area.

Minimum biotic resources occur on the MSP site, primarily, because the site is paved. Pigeons, sparrows, rats, and mice may be found on the site.

4.3 SOCIOECONOMIC FACTORS

Three counties and numerous smaller political subdivisions are within an 8-km (5-mi) radius of the nearby MML. Political jurisdictions and major transportation routes are shown in Figure 4-3.

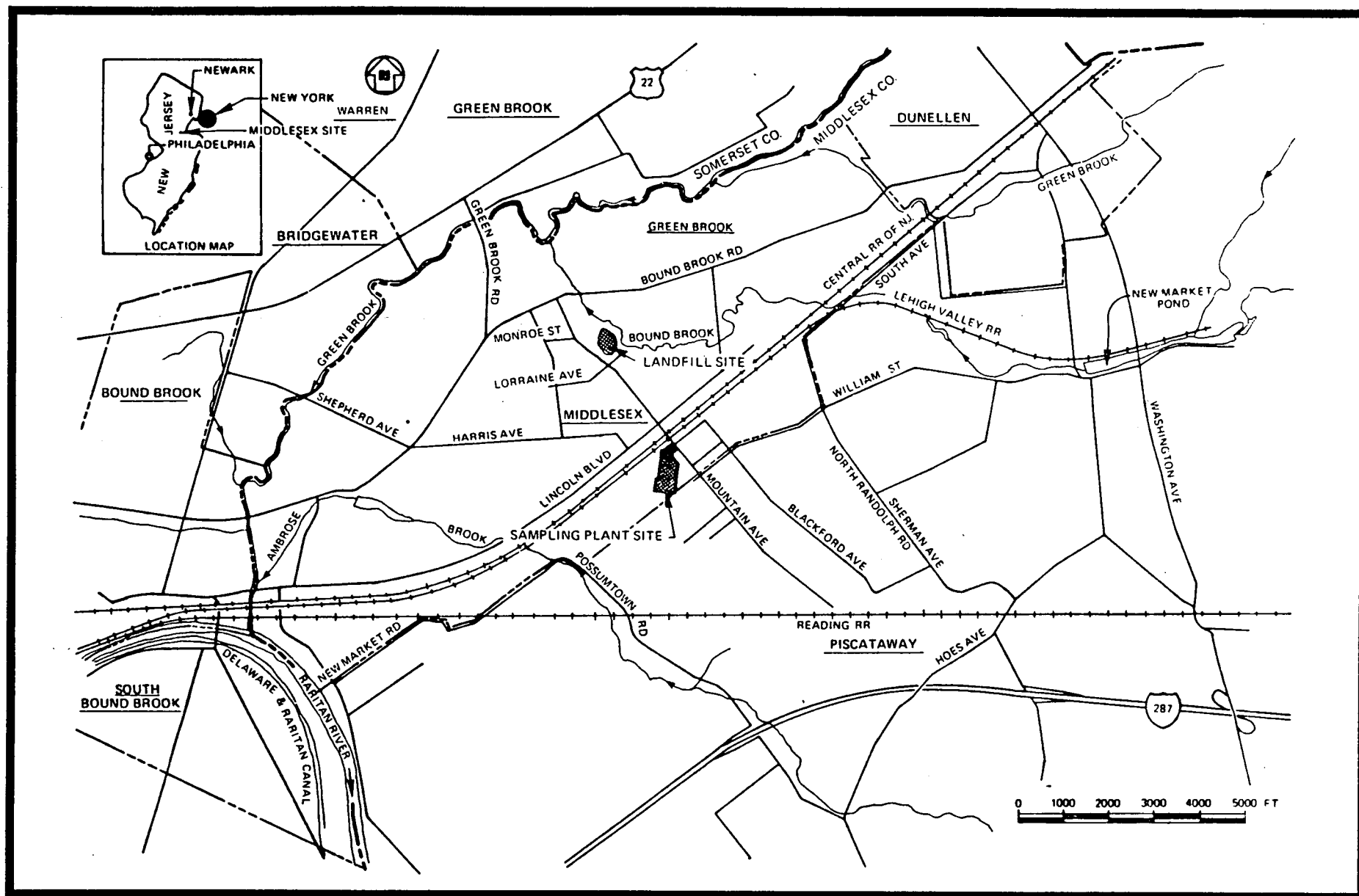
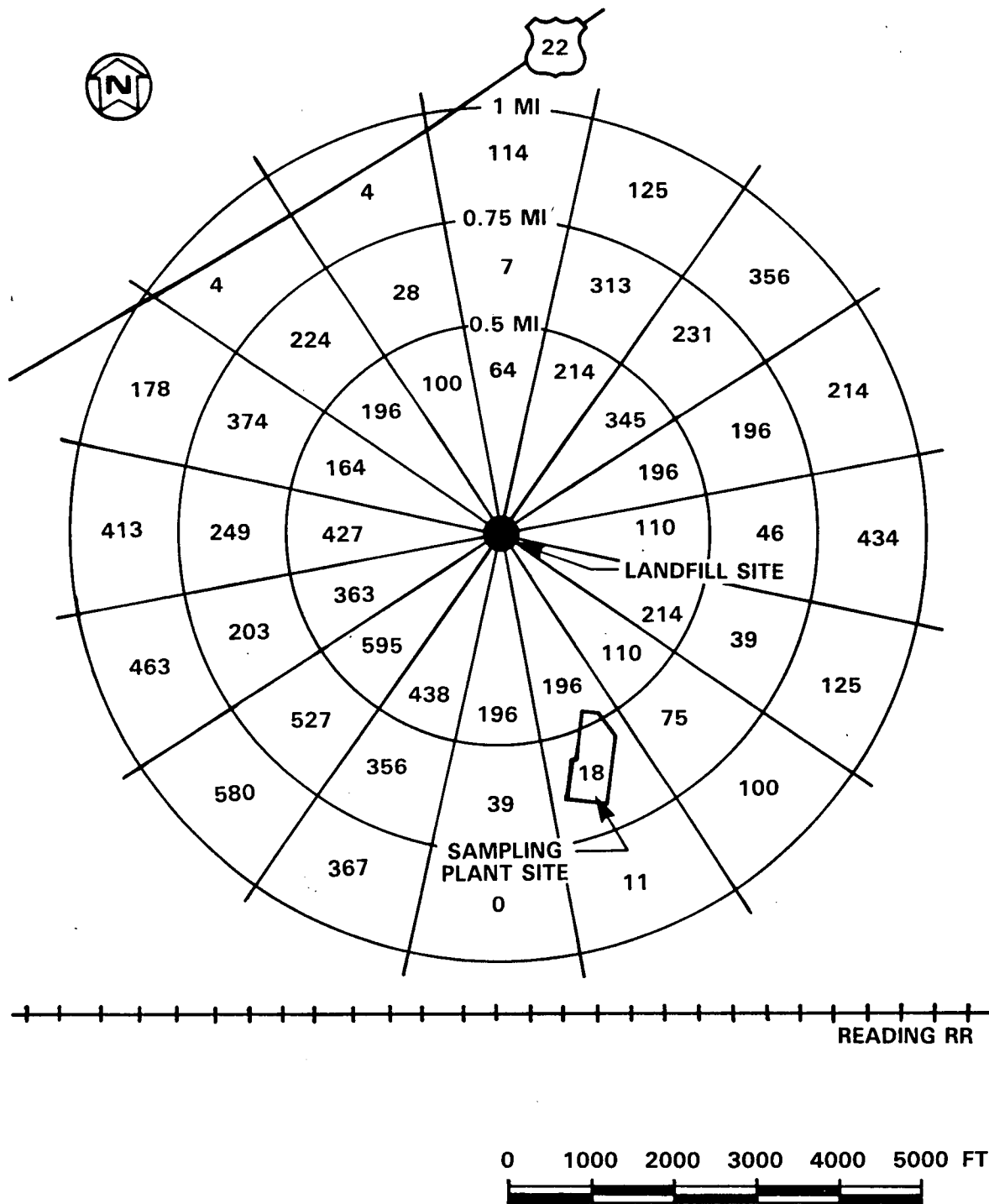


FIGURE 4-3 POLITICAL JURISDICTIONS AND MAJOR TRANSPORTATION ROUTES IN THE MSP VICINITY

The residential population within 0.8, 1.2, and 1.6 km (0.5, 0.75 and 1 mi) of the MML site was estimated from a count of residences within each sector. The population distribution is shown in Figure 4-4. The residential population within 1.6 km (1 mi) of the MML site boundary is estimated at 10,400 people living in approximately 2,900 dwellings. The residential population within 1.6 km (1 mi) of MSP is expected to be similar.

Approximately 6,000 people are employed at firms located within 1.6 km (1 mi) of the nearby MML site. Most of the employees are working in the industrial and commercial zones along Lincoln Boulevard, South Avenue, Bound Brook Road, and State Route 22. Generalized land uses in the vicinity of MSP are shown in Figure 4-5.



SOURCE: FBDU 1979

FIGURE 4-4 POPULATION DISTRIBUTION AROUND MSP AND MML

5.0 GEOLOGY

5.1 TOPOGRAPHY

The MSP site slopes gently from approximately 18 m (60 ft) above mean sea level (msl) on the northern side to 15 m (50 ft) msl on the southern side. The highest point of the site is at the gate at the north end; the point gradually slopes to the fence line on the south end of the site.

5.2 GEOLOGY AND SOILS

Soils at MSP consist of silty or sandy loams ranging in thickness from 0.45 to 2.4 m (1.5 to 8 ft). All on-site surface water from the storage pile and adjacent areas is conveyed via an underground drainage system to a settling basin. Overflow from the settling basin is directed to the easement ditch south of the site that discharges into a small brook known as Main Stream, which flows west to Ambrose Brook, a tributary to the Raritan River.

Depth of the soil to bedrock on the site ranges from 0.45 to 2.4 m (1.5 to 8.0 ft). A zone of 0.3-m- (1-ft-) thick weathered bedrock is situated above the sound bedrock surface. The weathered zone is a red, cohesive, clayey silt with bedrock fragments, retaining little visible structure and corresponding to descriptions of Reaville soil. Above the weathered shale in Area A (Figure 5-1) is a layer of fill, which includes cinders, crushed stone, and gray silt. A geologic cross-section of Middlesex County is included in Figure 5-2.

The bedrock is red shale of the Brunswick formation. Thin coatings [5 mm (1/8 in.)] of nonmagnetic black material were found infrequently along fracture surfaces. Locations of boreholes are shown in Figure 5-3. Localized beds of gray-green shale were encountered in boreholes DOE-4A and DOE-5A. These beds were between 1 and 2 cm (0.4 and 0.8 in.) thick and occurred in clusters of up to four beds. In DOE-8 and DOE-5A, calcareous material occurred in

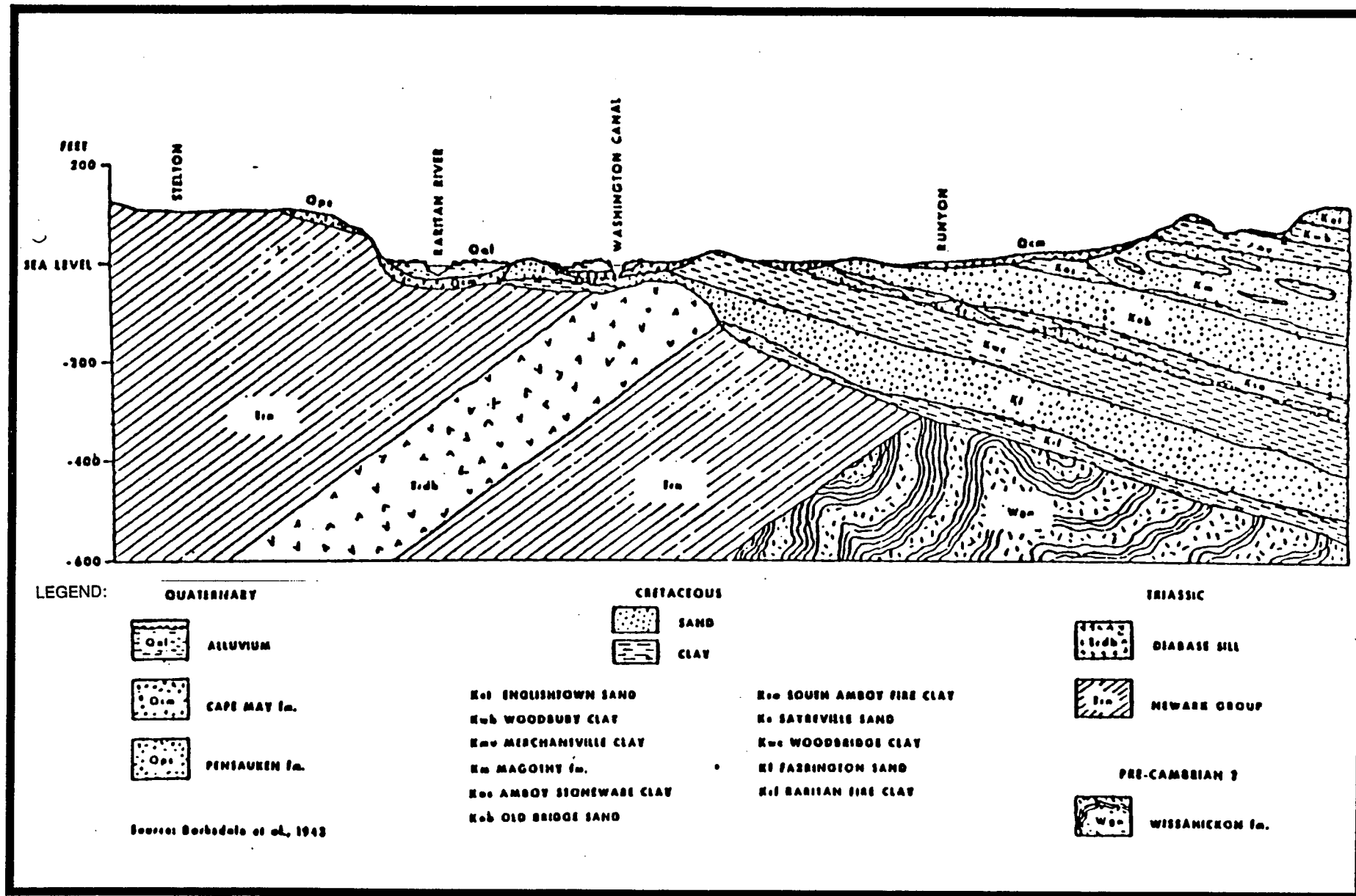


FIGURE 5-2 GENERALIZED GEOLOGIC SECTION —
MIDDLESEX COUNTY

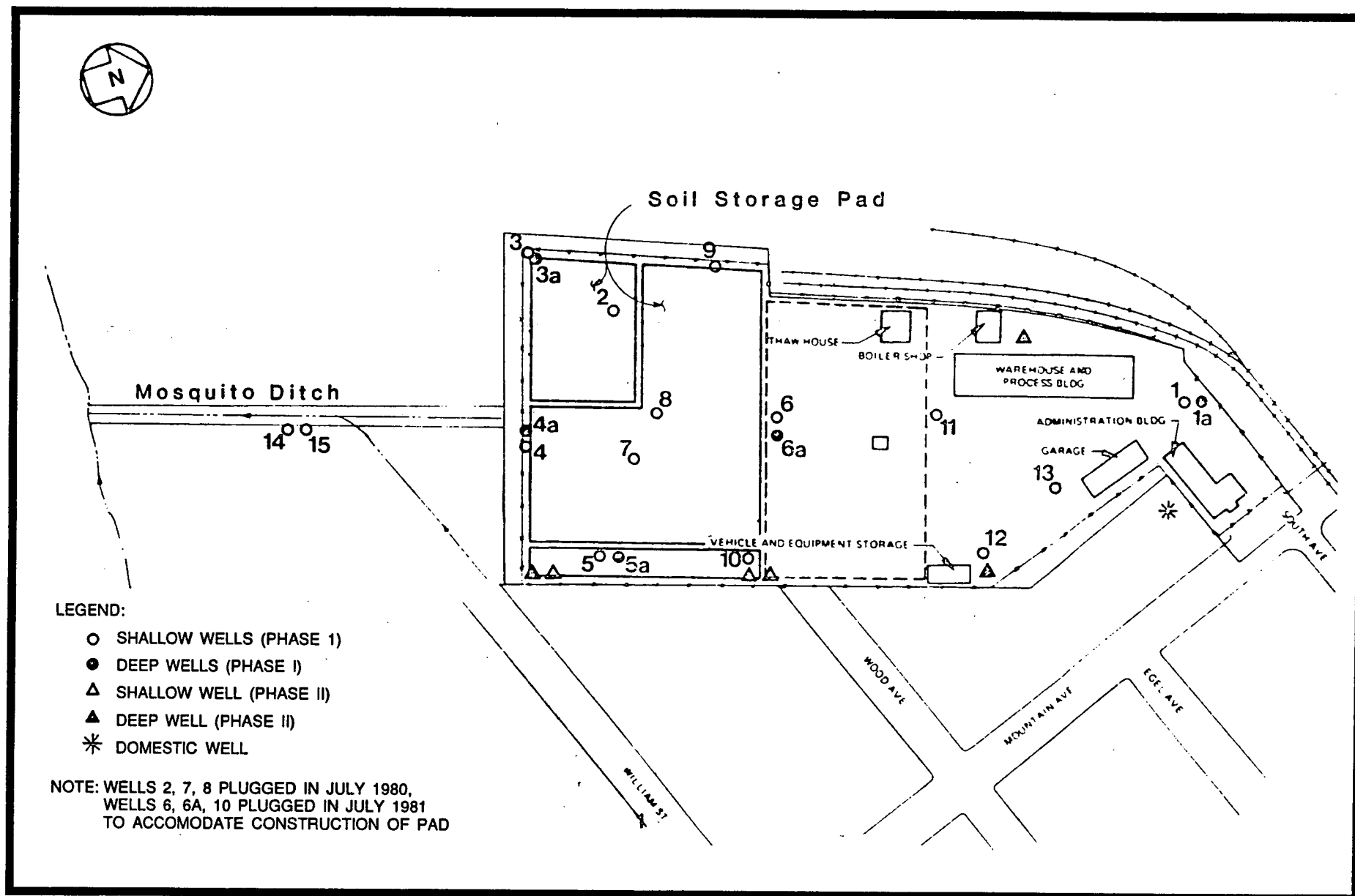


FIGURE 5-3 GROUNDWATER MONITORING WELLS AT MSP

zones approximately 1 cm (0.4 in.) thick; this material appears to have been deposited as joint filling. The calcareous zones occasionally exhibited small solution cavities. In DOE-5A, these zones were associated with the gray-green shale beds.

The shale commonly exhibited fissility, possibly induced by unloading fractures. There is no evidence that the fissile zones indicate pervasive, open fractures capable of transmitting water, except at DOE-6A. In this borehole, a 2.7-m (9-ft) zone of extremely fissile shale was encountered from 4.3 to 7 m (14 to 23 ft) below the surface. During drilling, air circulation was lost completely in this interval, indicating the development of an extensive open fracture. This fracture was confirmed in the slug test conducted at this borehole. Air circulation was not lost, nor was water encountered in any other boreholes located in zones of fissile shale.

6.0 HYDROLOGY

Middlesex County lies within two major physiographic provinces--the Atlantic Coastal Plain and the Piedmont Province. The portion of the county west of the Lawrence Brook and north of the Raritan River is generally within the Piedmont Province, and the remainder of the county is within the Atlantic Coastal Plain. The Piedmont Province is generally characterized by clay and shale formations with relatively high surface runoff rates, and the Atlantic Coastal Plain is characterized by sand and gravel formations with a higher infiltration rate.

The topography of Middlesex County is nearly level at some points and gently rolling at others, with maximum elevations of approximately 73.2 m (240 ft) msl in the southwestern part of South Brunswick Township. The lowest elevations approach sea level at the tidal areas on Raritan Bay and at the mouth of the Raritan River. As a result of its natural topography and its proximity to Raritan Bay, the county contains numerous natural drainage ways, the majority of which drain to the Raritan River and ultimately into Raritan Bay (Figure 6-1). Streams in the eastern area of the county drain directly to the Raritan Bay, and several in the northeastern portion of the county are tributaries of the Rahway River or drain directly to the Arthur Kill.

6.1 SURFACE WATER

The quality of the surface waters in Middlesex County varies, but the major streams are generally not suitable for potable water. The Middlesex Water Company has diversion rights on the Raritan River downstream from the MML site, but the utility is not using these rights; it prefers instead to obtain water from the Delaware-Raritan Canal.

Figure 6-1 shows the major drainage basins in the vicinity of MSP. Figure 6-2 shows the surface water sampling locations and drainage near MSP.

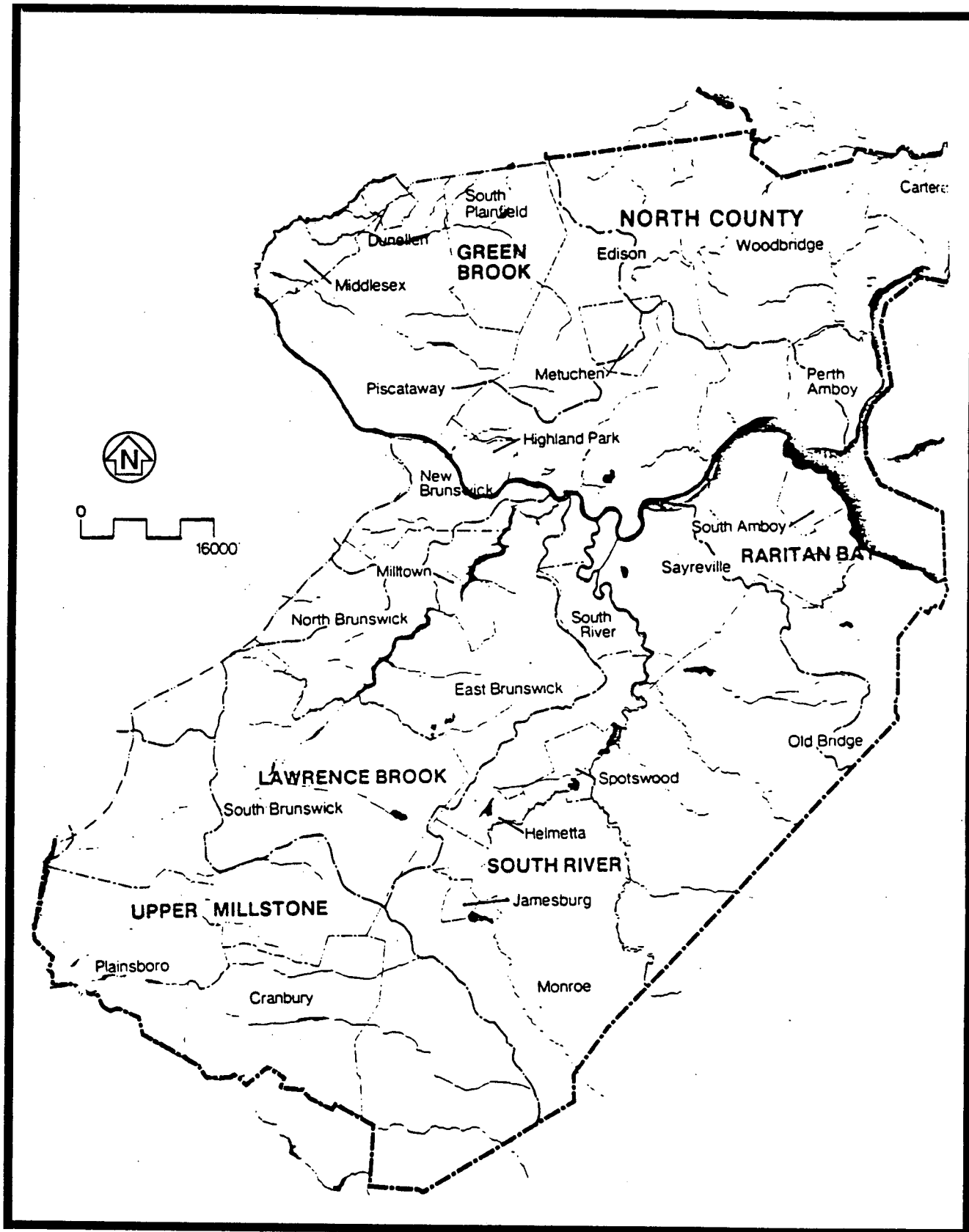


FIGURE 6-1 MAJOR DRAINAGE BASINS — MIDDLESEX COUNTY

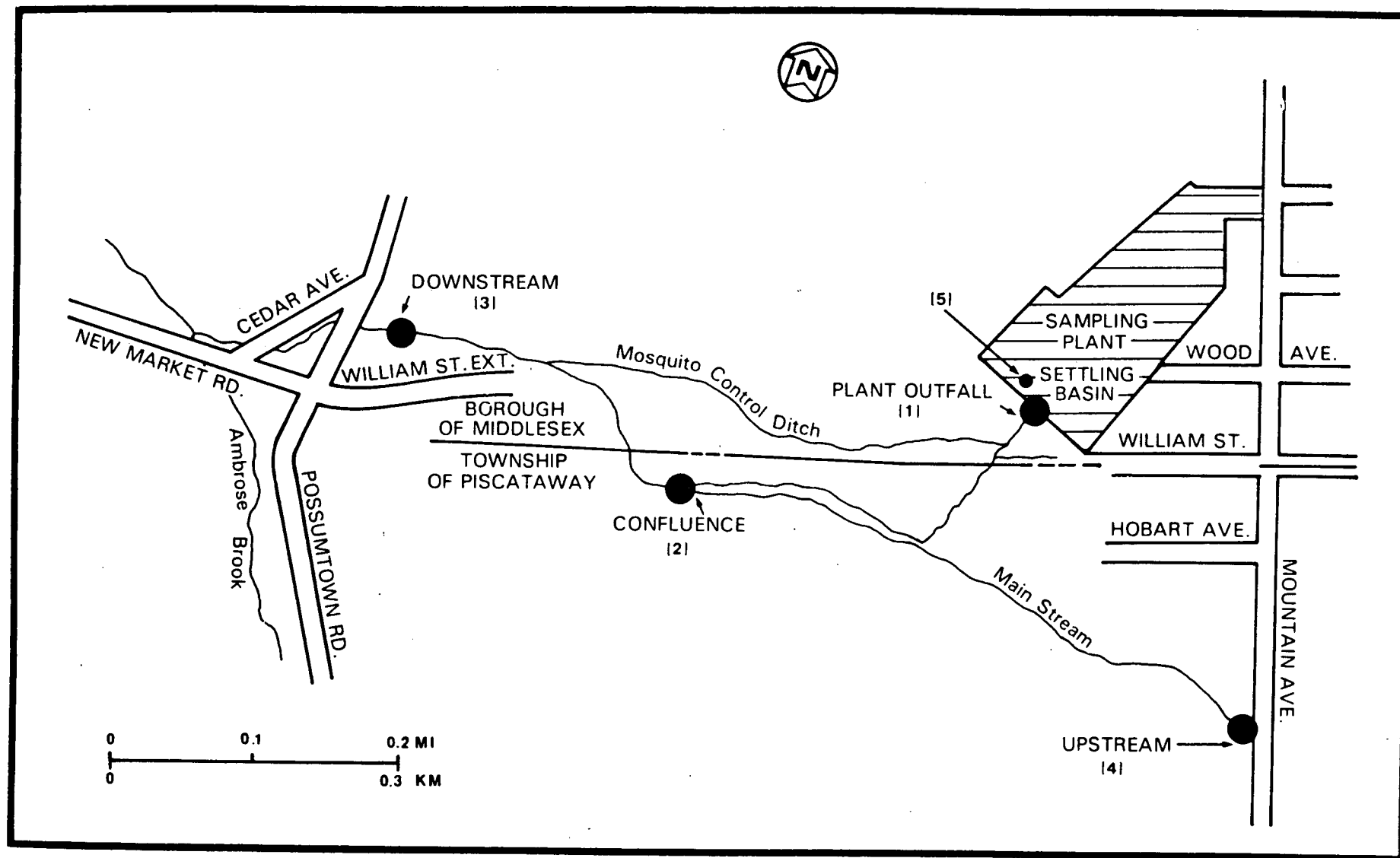


FIGURE 6-2 SURFACE WATER SAMPLING LOCATIONS AND DRAINAGE NEAR THE MSP SITE

Surface water samples collected at MSP from 1980 through 1987 showed a range of uranium-238 concentrations from 1.5 to 234 pCi/L and a range of radium-226 concentrations from 0.01 to 100 pCi/L at various sampling locations.

6.2 GROUNDWATER

Groundwater occurs in the secondary porosity of the Brunswick Formation as a result of fractures. The fracture-flow system offers little natural filtration and purification once water reaches the formation. The Brunswick Formation is a major aquifer in the western part of Middlesex County and adjoining Essex County. A number of private water supply wells are located within 1.6 km (1 mi) of MSP. These wells are shown in Figure 6-4. A public well field, Sebrings Mill Well Field, is located 2 km (1.25 mi) northwest of MSP. The Elizabethtown Water Company Sebrings Mill Well Field (Figure 6-4) supplies as much water as 1.3 mgd.

Roy F. Weston was contracted by Union Carbide Corporation to assess the subsurface soil and groundwater conditions at the portion of the MSP designated as Area A, shown in Figure 5-1. Weston's field program included the following activities:

- o Completion of 15 boreholes to bedrock and five boreholes into bedrock
- o Collection of split-spoon samples or core samples to provide a geologic log of each borehole
- o Permeability measurements using slug tests in shallow and deep boreholes
- o Examination of soil samples from split-spoon samples
- o Radiologic logging of each borehole to determine the activity present in the soil and bedrock

In addition, a number of samples of representative soil, bedrock, and groundwater were collected and analyzed for radium-226, uranium-238, thorium-232, gross alpha, and gross beta.

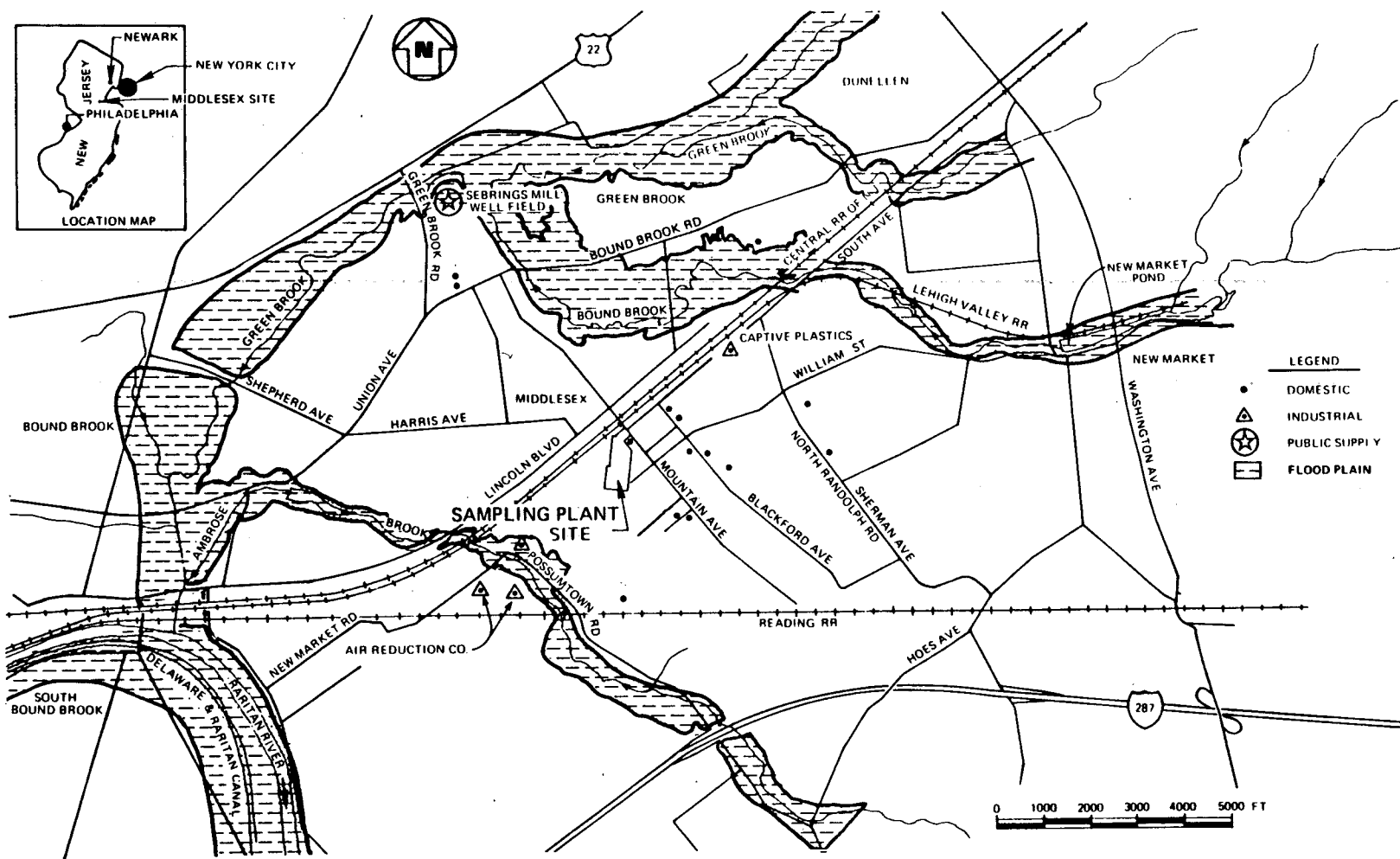


FIGURE 6-3 FLOODPLAINS AND APPROXIMATE LOCATION OF WELLS IN VICINITY OF MSP

The data collected during the field activities, beginning in May 1980 and concluding in early August 1980, were used to define the groundwater flow system at the site. Water level elevations for 1980 are shown in Table 6-1. Precipitation data for the period of measurement are shown in Table 6-2. Figure 5-3 shows the locations of the groundwater monitoring wells. Figures 6-5 and 6-6 show groundwater contours using data collected from the shallow and deep wells in 1988.

With the exceptions of DOE-3, DOE-7, and DOE-9, water levels in all boreholes rose between June 10 and July 2, 1980. The most reasonable explanation for these fluctuations is disruption of the drainage system by site preparation and construction activities. Preparation of the site for the construction of the new asphalt pad began during the first week of July. Site preparation involved the removal of the subsurface drainage system with the attendant excavation as well as removal of the paving over most of Area A. Prior to the beginning of site preparations, the silty clay soil above the bedrock presented a low-permeability barrier to the vertical flow of water from the near surface to bedrock. In removal of the drainage system, that barrier was disturbed.

These changes in drainage patterns were apparently local and did not affect the flow of groundwater under the site.

6.2.1 Shallow Groundwater

Groundwater in the shallow system is approximately 3.0 m (10 ft) below the surface and has a low-flow velocity. Low transmissivity, determined in slug tests on DOE-8 and DOE-12 and the low hydraulic gradient [0.3 m/18 m (1 ft/60 ft)], are indicative of a low-groundwater flow velocity. The shallow boreholes were cased and screened through the parking lot subbase; therefore, the low transmissivity is representative of weathered shale and silty fill material and does not reflect the effect of the more permeable coarse-grained fill material. Flow is in a southerly direction. A minor flow component is to the northeast toward DOE-13.

TABLE 6-1
GROUNDWATER ELEVATIONS AT THE MSP SITE, 1980

Boring	Elevation in ft above msl				
	6/18/80	7/2/80	7/10/80	7/22/80	7/31/80
DOE 1	51.73	53.68	54.00	53.35	53.85
DOE 1A	46.42	47.46	47.06	44.32	47.00
DOE 2	49.02	49.33	48.17	Paved Over	--
DOE 3	49.23	49.02	47.51	48.78	48.95
DOE 3A	46.90	47.20	47.30	47.24	47.10
DOE 4	44.19	44.75	44.96	44.97	45.58
DOE 4A	43.00	43.19	43.23	43.60	43.60
DOE 5	46.50	46.82	46.72	45.39	47.80
DOE 5A	27.93	27.65	27.73	29.20	-a-
DOE 6	51.10	51.28	51.22	50.45	51.64
DOE 6A	36.12	36.34	36.26	36.47	41.42
DOE 7	47.96	47.95	47.83	Paved Over	--
DOE 8	48.92	49.10	49.04	Paved Over	--
DOE 9	51.91	51.76	52.71	54.73 ^b	54.73 ^b
DOE 10	50.03	50.74	50.70	50.52	Paved Over
DOE 11	52.72	53.82	53.41	52.29	53.50
DOE 12	52.95	54.06	53.50	52.40	53.63
DOE 13	51.58	52.32	51.72	52.80	54.41
DOE 14	43.51	43.77	43.62	43.22	43.59
DOE 15	44.61	44.76	44.65	44.57	44.80

^aWell 5A--Block in the casing.

^bWell 9--Cap had been removed.

TABLE 6-2
DAILY PRECIPITATION RECORDED AT
NEWARK INTERNATIONAL AIRPORT^a

Date	Precip. Recorded (in.)	Date	Precip. Recorded (in.)
June 12	0	July 9	0
13	0	10	0
14	0	11	Trace
15	0.04	12	Trace
16	0	13	0
17	0	14	0
18	0	15	Trace
25	0	16	0.09
26	0	17	0.03
27	0	18	0
28	0	19	0
29	1.20	20	0
30	0.02	21	0.43
July 1	0	22	0.02
2	0.04	23	0
3	0.01	24	0
4	0	25	0
5	0.23	26	Trace
6	0	27	0
7	0	28	Trace
8	Trace	29	1.93
		30	0
		31	Trace

^aMeasurements taken in 1980.

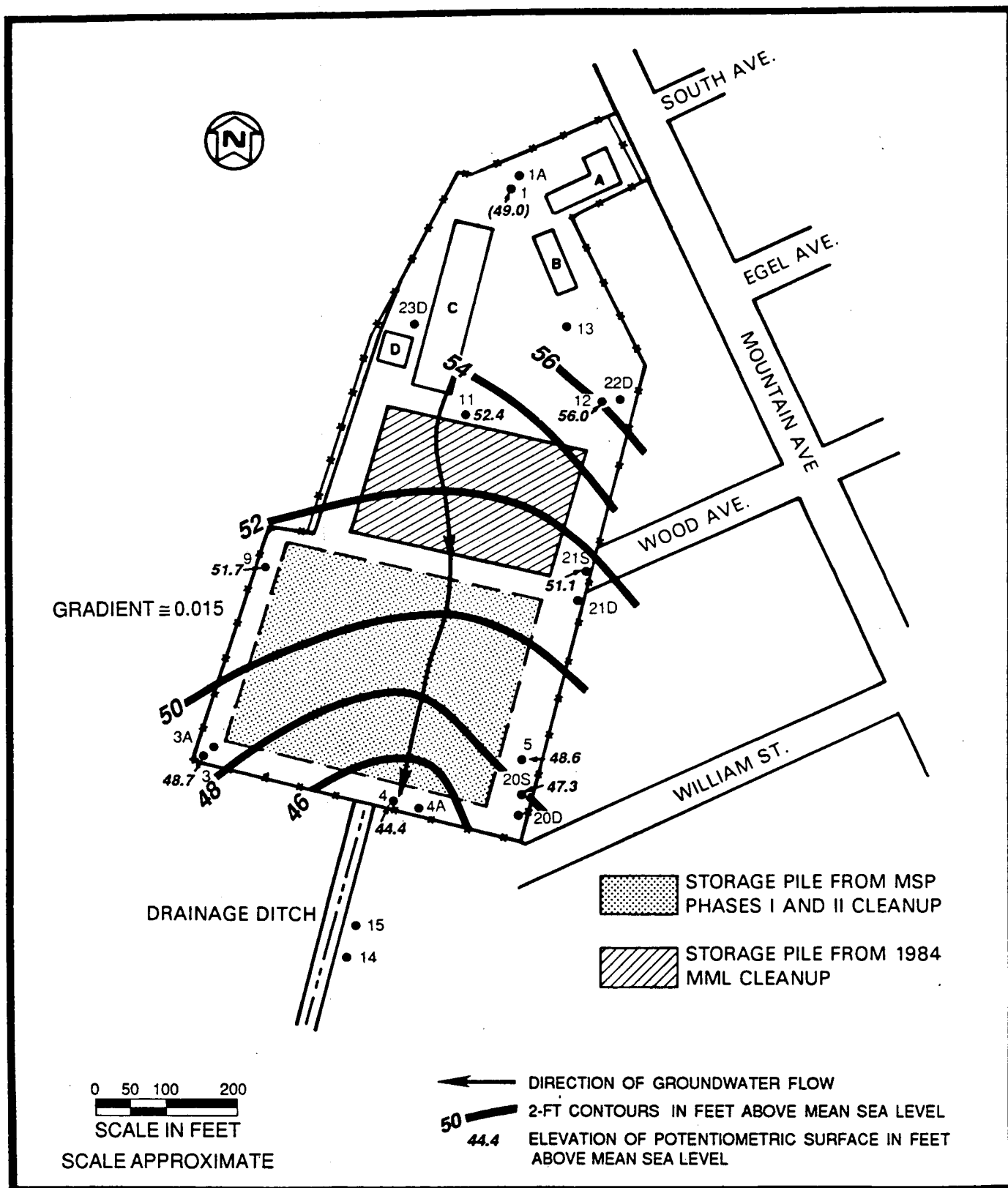


FIGURE 6-4 MSP GROUNDWATER POTENTIOMETRIC SURFACE — SHALLOW WELLS (3/28/88)

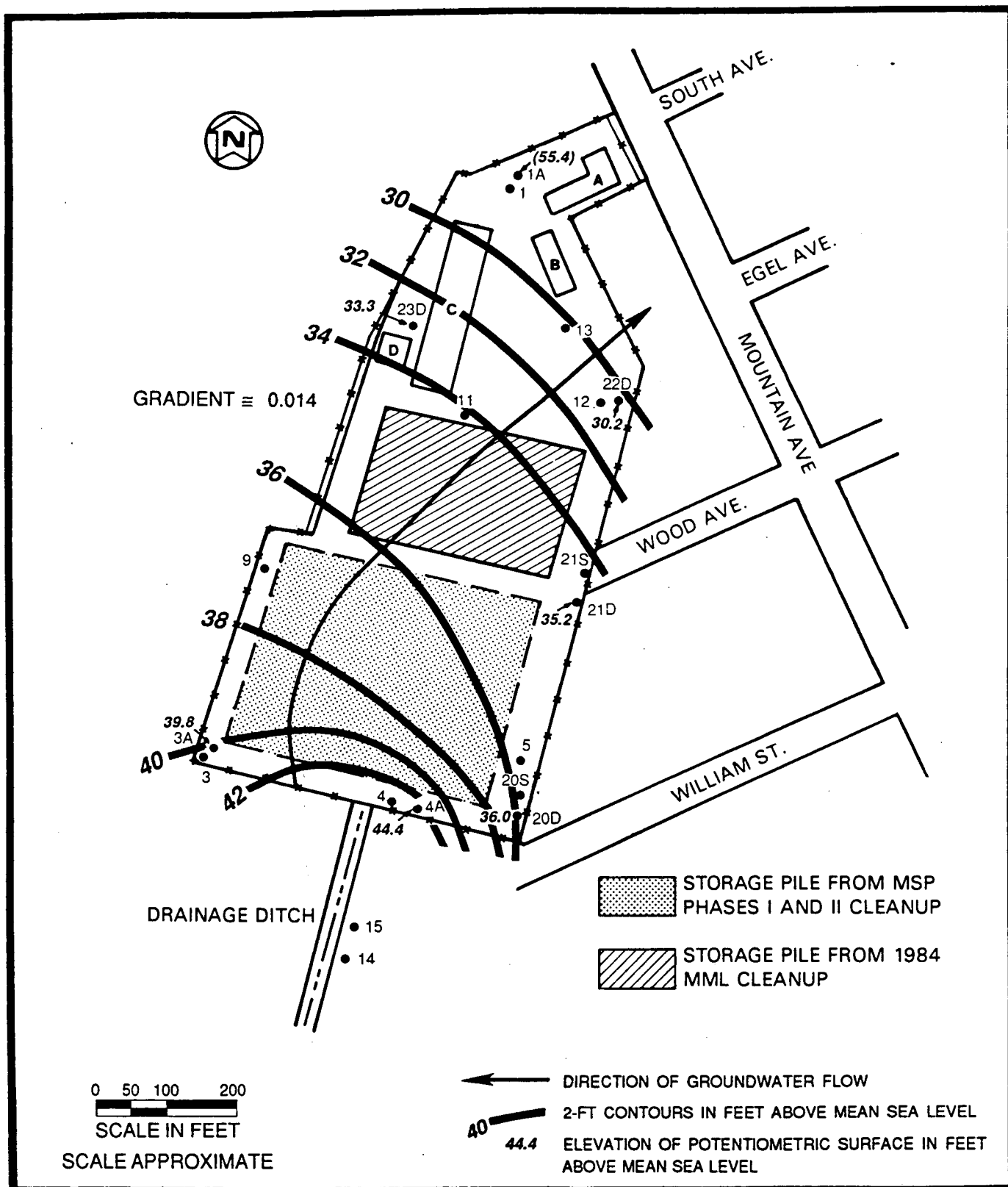


FIGURE 6-5 MSP GROUNDWATER POTENTIOMETRIC SURFACE — DEEP WELLS (3/24/88)

6.2.2 Bedrock Groundwater

The calcareous zones and solution cavities observed in the core samples along with the changes in drilling characteristics suggest an increase in transmissivity at the 4.6- to 7.6-m (15- to 25-ft) depth in the deeper boreholes. The slug tests performed in the deep boreholes corroborate the increase in transmissivity.

The bedrock aquifer also shows a steeper groundwater hydraulic gradient [0.3 m/2.7 m (1 ft/9 ft)], which, coupled with the higher transmissivity, is indicative of a higher groundwater flow velocity. Flow in the bedrock system is toward the east. Figure 6-6 indicates that flow is toward the Wood Avenue gate. It is possible that this is an artificial trend since this interpretation is dependent on the water level in DOE-6A, which encountered a major fracture. The limited number of deep borings made individual water levels important in the interpretation of the potentiometric surface contours.

The transmissivity values for the deep borings are given below.

<u>Boring No.</u>	<u>Transmissivity (gpd/ft)</u>
DOE-1A	69
DOE-4A	73
DOE-5A	105
DOE-6A	115
DOE-8	7
DOE-12	22

Transmissivity determined at DOE-6A was the highest and, during drilling of DOE-6A, was the only borehole that showed a significant open fracture; therefore, the high transmissivity was expected. Transmissivity at DOE-5A was close to that at DOE-6A, although a major open-fracture zone was not encountered during drilling. However, a minor fracture was noted at the 7.3- to 7.6-m (24- to 25-ft) depth. In addition, DOE-5A also encountered a large number

of calcareous joint fillings from approximately 6.1 m (20 ft) below the surface to the bottom of the boring. Although thin and apparently not laterally extensive, these zones appeared to be quite open as a result of dissolution of the calcareous material. This would account for the high transmissivity resulting from the slug test.

Weston reports that, based on examination of the samples taken during drilling and the results of slug tests on DOE-1A and DOE-4A, a transmissivity of approximately 97 Lpd/m (70 gpd/ft) is representative of the on-site bedrock, except where open fractures are encountered.

7.0 STORAGE PILE CONSTRUCTION

As part of the remedial actions performed by NLO, an 11,100-m² (120,000-ft²) asphalt pad was constructed in the storage area. Because of the poor condition of the old pavement, a 2.5-cm (1-in.) leveling course of bituminous concrete was initially applied to the storage pile area. Then the 3.8-cm (1.5-in.) hot-mix bituminous-concrete top course, underlaid with a nonwoven paving grade polypropylene fabric, was subsequently installed over the asphalt-leveling course and rolled to achieve 95 percent Marshall density.

A 1.5-mm (60-mil) standard nylon-reinforced ethylene propylene diene monomer, manufactured by Carlisle Tire and Rubber, was installed as a cover for the contaminated materials. First, a 1-m- (3-ft-) wide perimeter tuck piece was bonded to the asphalt pad with cement. The edge pieces and border timbers were then spliced, cemented, and bolted together. The remainder of the liner was then put in place. Each lap splice was cleaned with unleaded gasoline prior to applying the jointing cement, according to the manufacturer's instructions. A minimum 15-cm (6-in.) lap was maintained for every splice. Upon completion of the splice, a lap sealant was applied to improve the integrity of the cemented-lap splice.

A different storage pile construction was employed for the waste from remedial action performed by BNI. A 45.7-cm- (18-in.-) high concrete curb was constructed around the perimeter of the storage area, and 15.2 cm (6 in.) of silty sand was placed within it to form a smooth, graded base. A 0.91-mm (36-mil) geomembrane liner was then placed on the sand and lapped up and attached to the top of the curb with battens. A 15.2-cm (6-in.) layer of permeable sand was then spread over the geomembrane to act as a leachate collection system, and contaminated material placement began. As portions of the storage area were completed, they were covered with a geomembrane stockpile cover. The battens attaching the bottom liner to the curbs were removed; the cover and liner were sealed together; and the battens were reinstalled. The wastes were thus completely

encapsulated by the geomembrane liner and cover. A sump riser was installed at the lower end of the storage pile to allow removal of any leachate that might collect in the collection system.

The collection system was provided only to collect any water that exceeded the moisture-holding capacity of the material that was present in the contaminated material when the storage piles were constructed. If leachate is generated, it is collected by a commercial wastewater treatment facility for off-site treatment and disposal. No on-site treatment will take place. Approximately, 909 L (200 gal) of wastewater was removed from the leachate collection system after the piles were covered. No wastewater has been collected since, and none is anticipated.

8.0 SUMMARY OF CONTAMINATION

8.1 ORNL SURVEY

During 1976, a radiological survey of MSP was conducted by the Oak Ridge National Laboratory (ORNL). During this survey, measurements of activity were made in buildings and soil, and external gamma radiation levels were determined. Groundwater was not sampled.

8.1.1 Soil Survey

Soil samples were collected at 46 locations on the site and at 2 background locations. One of the background samples was collected in sandy soil across Mountain Avenue from the Municipal Building; the other sample was collected in the same type of soil that occurs at the site at the corner of Lincoln and Mountain Avenues. On-site radium-226 concentrations ranged from 0.8 to 477 pCi/g, compared with background levels of 1.0 pCi/g and 1.7 pCi/g. The highest concentration of radium-226 (2401 pCi/g) was found in the drainage ditch south of the site.

Examination of these data shows that, with the exception of 4 locations, radium-226 concentrations did not exceed 5 pCi/g below a depth of 0.6 m (2 ft). These locations are immediately west and south of the Process Building shown in Figure 3-1; the laboratory was located in this building. The maximum radium-226 concentration was 57 pCi/g at a depth of from 1.2 to 1.5 m (4 to 4.8 ft). It is likely that the elevated concentrations of radium-226 resulted from accidental spillage and discharges from the waste disposal system of the building.

8.1.2 Summary of ORNL Survey

In summary, the ORNL survey showed that contamination near the surface was widespread throughout the site and was more prevalent in the vicinity of the Process Building. Changes in radium-226

concentrations were abrupt, both laterally and vertically. Background concentrations for radium-226 in groundwater were 0.29 pCi/L.

8.2 WESTON SURVEY

During the Weston evaluation of the groundwater for ORNL in 1980, a radiological investigation was conducted. This investigation consisted of three elements:

- o Radiological logging of all boreholes
- o Analysis of soil and rock samples from the boreholes
- o Analysis of groundwater samples

The results of rock and soil sample analyses are presented in Table 8-1; results of groundwater analyses are presented in Table 8-2.

8.2.1 Subsurface Soil and Rock Survey

Figure 8-1 is a graph developed by Radiation Management Corporation, based on the samples collected at MSP, which provides a correlation between counts per minute (cpm) and radium-226 concentration. Based on this figure, it can be stated that 40,000 cpm is generally indicative of a radium-226 concentration over 5 pCi/g. Only two boreholes, DOE-2 and DOE-6, displayed activity above 40,000 cpm. This level of activity occurred in the upper 0.9 m (3 ft) in DOE-2 and throughout DOE-6. Note that in DOE-6A, which is within 3.0 m (10 ft) of DOE-6, activity was an order of magnitude less.

TABLE 8-1

MSP REMEDIAL DECONTAMINATION PROJECT
SOLID SAMPLE ANALYSIS RESULTS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		Ra-226	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A Initial Site)	31387	341.	11	205.	10	44.0	10
DOE-1A #1 (Red Clay)	31389	14.5	64	38.2	13	0.734	17
DOE-1A #2 (Red Clay)	31388	32.2	39	41.5	12	3.54	10
DOE-2 Site (Asphalt)	31382	—	—	—	—	17.0	10
DOE-2 #1 (Fill Dirt)	31396	51.0	32	33.8	14	5.75	10
DOE-2 #2 (Red Clay)	31391	19.7	53	41.7	12	0.568	23
DOE-2 #3 (Subfill 1)	31393	29.1	42	27.8	16	4.99	10
DOE-2 #3 (Subfill 2)	31394	11.4	75	20.0	20	0.618	20
DOE-2 (Core 2.5-3.5 ft)	33917	38.2	33	32.7	12	—	—
DOE-2 (Core 4.0-5.0 ft)	33918	18.7	50	30.3	12	—	—
DOE-3A #1 (Sludge)	31385	18.4	54	26.9	15	0.590	22
DOE-4 #1 (Red Clay)	32768	9.38	73	23.5	17	1.05	16
DOE-5 #1 (Auger Soil)	32769	12.5	62	27.6	15	0.696	21
DOE-5 (Core 5.0-5.5 ft)	33919	<4.9	—	21.2	16	—	—
DOE-5A #1 (Red Clay)	31392	14.6	64	28.1	16	0.761	19
DOE-6 (Core 1.0-2.5 ft)	33921	212.	13	185.	10	—	—
DOE-6 (Core 2.5-4.3 ft)	33922	63.4	25	42.7	10	—	—
DOE-6 (Core 4.3-6.0 ft)	33923	6.38	10	4.94	10	—	—
DOE-6 (Core 6.0-7.5 ft)	33924	2.47	43	2.43	15	—	—
DOE-6A #1 (Gray Mud)	31395	1.77	63	2.36	18	2.02	11
DOE-6A #2 (Red Clay)	31390	1.45	64	2.73	15	0.575	21
DOE-7 #1 (Auger Soil)	32770	4.74	30	7.99	10	1.95	12
DOE-7 (Core 3.0-5.0 ft)	33930	5.14	30	7.78	10	—	—
DOE-8 #1 (Tailings)	32771	2.19	43	2.30	18	3.02	10
DOE-10 #1 (Subasphalt)	32765	1.31	10	2.42	10	793.	10
DOE-11 #1 (Auger Soil)	32766	2.20	49	3.77	12	14.7	10
DOE-13 #1 (Auger Soil)	32767	9.93	20	8.66	10	1.98	12
DOE-14 (Core 0.5-1.5 ft)	33935	7.52	23	6.25	10	—	—
DOE-14 (Core 3.5-4.0 ft)	33936	2.25	45	3.81	11	—	—

TABLE 8-1
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	52.3	9	2.06	23	54.9	9
DOE-1A #1 (Red Clay)	31389	1.03	28	0.063	—	0.611	38
DOE-1A #2 (Red Clay)	31388	1.69	15	0.182	44	1.40	16
DOE-2 #1 (Fill Dirt)	31396	10.2	11	0.420	43	1.04	11
DOE-2 #2 (Red Clay)	31391	0.897	33	<0.14	—	0.874	34
DOE-2 #3 (Subfill 1)	31393	18.6	12	<0.56	—	18.2	17
DOE-2 #3 (Subfill 2)	31394	1.07	25	0.061	—	0.548	33
DOE-4 #1 (Red Clay)	32768	1.22	23	<0.14	—	1.33	23
DOE-5 #1 (Auger Soil)	32769	5.38	15	<0.21	—	4.04	17
DOE-6A #1 (Gray Mud)	31395	3.27	6	0.225	52	2.75	16
DOE-6A #2 (Red Clay)	31390	0.560	38	0.057	—	0.618	36
DOE-7 #1 (Auger Soil)	32770	2.30	17	0.080	—	2.00	20
DOE-8 #1 (Tailings)	32771	4.80	13	0.187	54	4.39	13
DOE-10 #1 (Subasphalt)	32765	329.	11	<0.21	285.	33	
DOE-11 #1 (Auger Soil)	32766	6.59	14	0.289	52	7.07	13
DOE-13 #1 (Auger Soil)	32767	17.0	9	0.412	38	16.5	10

TABLE 8-1
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	490.	20	9.18	42
DOE-1A #1 (Red Clay)	31389	50.1	62	9.19	48
DOE-1A #2 (Red Clay)	31388	7.52	24	3.62	33
DOE-1A #3 (Sludge)	31386	8.46	30	6.07	35
DOE-2 #1 (Fill Dirt)	31396	63.2	20	6.28	40
DOE-2 #2 (Red Clay)	31391	5.26	44	8.24	37
DOE-2 #3 (Subfill 1)	31393	164.	21	7.32	49
DOE-2 #3 (Subfill 2)	31394	4.66	52	7.67	43
DOE-4 #1 (Red Clay)	32768	13.1	34	8.59	37
DOE-5 #1 (Auger Soil)	32769	4.13	44	6.37	37
DOE-6A #1 (Gray Mud)	31395	22.2	27	5.78	43
DOE-6A #2 (Red Clay)	31390	3.04	56	5.21	44
DOE-7 #1 (Auger Soil)	32770	7.85	32	4.93	39
DOE-8 #1 (Tailings)	32771	50.3	24	14.1	32
DOE-10 #1 (Subasphalt)	32765	2690.	16	6.70	37
DOE-11 #1 (Auger Soil)	32766	58.4	22	6.31	43
DOE-13 #1 (Auger Soil)	32767	111.	18	5.57	39

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey--Final Report, October 1980.

TABLE 8-2

MSP GROUNDWATER QUALITY ANALYSIS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		Ra-226	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	56.3	21	<2.3	—	0.439	45
DOE-3A	32755	49.5	21	16.2	18	0.729	36
DOE-4	32760	4.54	75	3.98	62	0.237	57
DOE-4A	32757	11.2	44	58.7	10	0.450	56
DOE-5	32761	8.82	53	8.56	32	0.118	94
DOE-5A	32758	<1.8	—	20.0	17	0.187	91
DOE-6 7/3/80	32762	2740.	10	432.	10	474.	10
DOE-6A 7/3/80	32759	6.47	75	<2.4	—	0.219	70
DOE-6 7/31/80	35788	3050.	10	—	—	—	—
DOE-6A 7/31/80	35805	13.5	50	15.9	18	—	—
DOE-8	32763	66.7	19	15.6	20	1.94	20
DOE-9	35789	17.3	28	6.27	10	—	—
DOE-11	35790	4.19	60	4.33	51	—	—
DOE-12	35791	<1.48	—	<2.02	—	—	—
DOE-13	35792	<1.83	—	130.0	10	—	—
DOE-14	32764	5.99	75	<2.30	—	—	26

TABLE 8-2
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	6.36	24	<0.54	64	4.44	28
DOE-3A	32755	21.2	15	0.93		18.9	15
DOE-4	32760	0.655	10	<0.45		0.940	63
DOE-4A	32757	10.4	19	<0.70		12.0	18
DOE-5	32761	6.34	25	<0.27		5.24	27
DOE-5A	32758	1.77	45	<0.58	50	1.06	58
DOE-6	32762	1420.	10	<54.0		1430.	10
DOE-6A	32759	4.72	28	<0.57		2.45	38
DOE-8	32763	38.6	12	1.46		41.3	11
DOE-14	32764	1.98	43	<0.27		2.97	35

TABLE 8-2
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-3A	32755	6.98	40	9.08	36
DOE-4	32760	<4.5	--	<1.5	--
DOE-4A	32757	31.6	41	<5.5	--
DOE-5	32761	<9.0	--	<3.4	--
DOE-5A	32758	5.95	52	10.5	41
DOE-6	32762	115.	24	<5.3	--
DOE-6A	32759	<8.8	--	<5.4	--
DOE-8	32763	<4.7	--	<10.	--
DOE-14	32764	13.8	73	<5.2	--

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Site,
Middlesex, New Jersey--Final Report, October 1980.

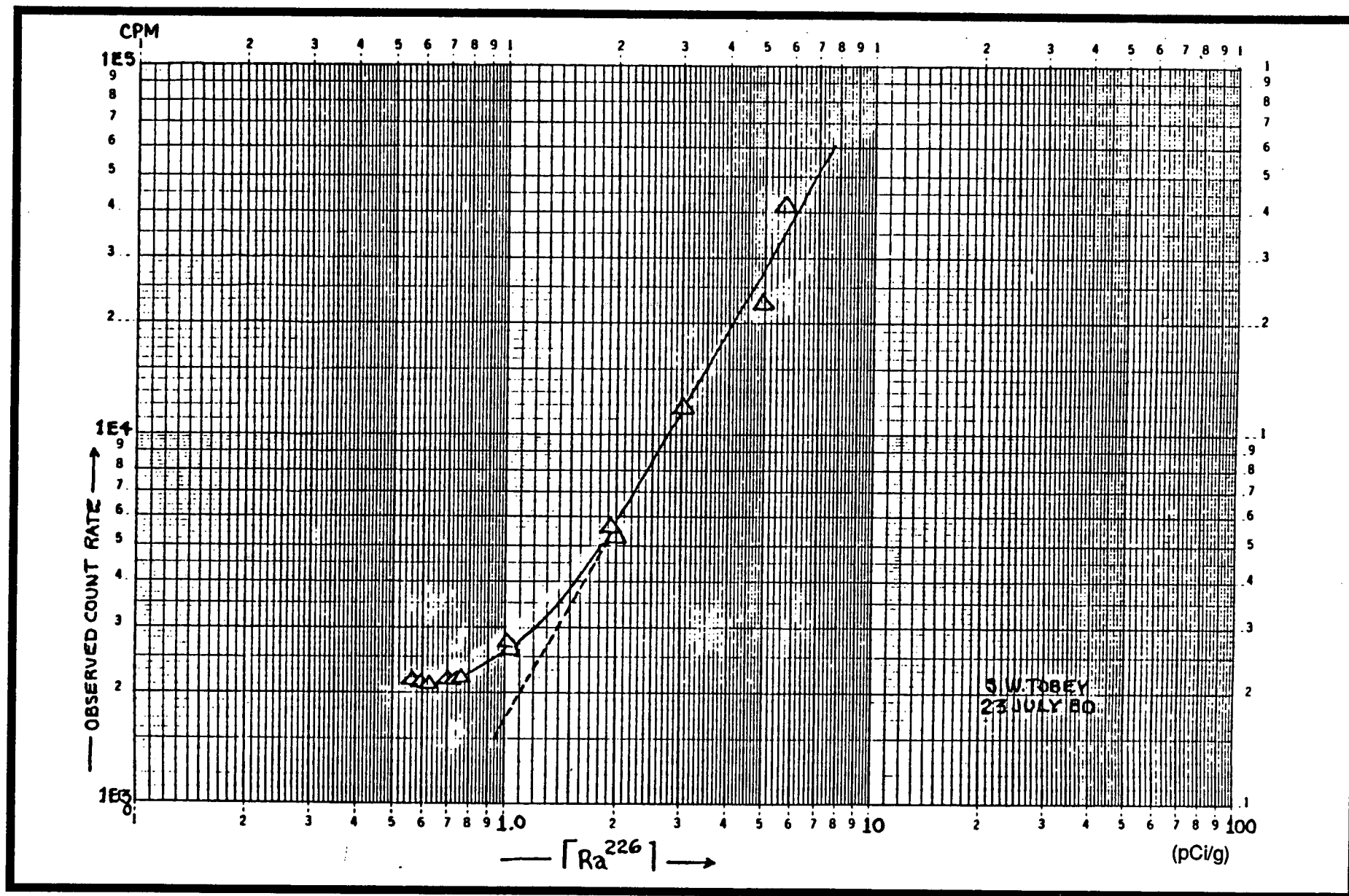


FIGURE 8-1 CORRELATION OF RADIUM CONCENTRATION
AND COUNTS PER MINUTE

No measurement above the background range was found in the bedrock. Background for the site as indicated by the ORNL data is 1.3 pCi/g of radium-226. The highest concentration of radium-226 (793 pCi/g) was found in the parking lot subbase at DOE-13. The lowest concentration of radium-226 (0.568 pCi/g) was found in the clay at DOE-2. No ORNL data were available for comparison at these locations.

Most soil samples contained low levels of radium-226, usually an order of magnitude below 5 pCi/g. All clays sampled were below this level as were the subfill samples. The asphalt sample from DOE-2 was high at 17.0 pCi/g.

The concentrations of uranium-238 in soil samples ranged from 0.518 to 285.0 pCi/g. The highest concentration was found in the subbase at DOE-10, which also had the highest radium-226 concentration. The lowest level (0.518 pCi/g) was found in the subfill-2 sample from DOE-2.

Comparison of these Weston data with the earlier ORNL data shows close agreement over most of the area. Both sets of data show that the upper 0.6 to 0.9 m (2 to 3 ft) of the site are the most active, with some exceptions.

Discrepancies exist between the two sets of data for high activity levels; high activity levels at a location in one set of data are not confirmed by nearby samples in the other set of data. Both sets of data do show that contamination is extremely localized (DOE-6 and DOE-6A, for example).

8.2.2 Groundwater Survey

Analysis of the groundwater on the site shows that groundwater in DOE-6 has the highest activity. Background, as determined by ORNL, is 0.29 pCi/L for radium-226. Water in six of ten wells showed radium-226 concentrations above this level. As shown in Table 8-2, with the exception of DOE-6, DOE-8, and DOE-14, the other boreholes

are only slightly above background. Activity in the soil at DOE-6 has already been described. Since DOE-6 shows high levels of contamination that are not found in other boreholes, it is suspected that this borehole may have been contaminated with surface contamination during drilling. In DOE-8, an elevation in activity from 0.7 to 1.1 m (2.3 to 3.6 ft) appears below the surface. DOE-14 is located adjacent to the ditch that has received most of the site drainage. This area appears to have been severely impacted by the deposition of contaminated soil that had been transported as suspended particles via surface water runoff and lateral transport through the parking lot subbase.

8.2.3 Summary of Weston Survey

In summary, the 1980 data show that radiological contamination in the soil on the site exists primarily in localized pockets that seldom extend beyond the site. This contamination only rarely occurs at depths greater than 0.9 m (3 ft) below the surface. The area of highest incidence of contamination is in the vicinity of the main building.

8.3 BNI SURVEY

In 1983, a radiological characterization of the MSP property was conducted by BNI. The survey characterized the boundaries and extent of contamination at the MSP property. It included both horizontal and vertical characterization of the grounds.

Indoor measurements were also made of the four buildings on the property: the process building, boiler house, administration building, and garage. Building exteriors were monitored in the same manner as the interiors. Surface measurements indicated extensive fixed alpha contamination in the process building and the boiler house. Surface measurements obtained in the garage and the administration building identified several areas of elevated levels of contamination in each building.

8.3.1 Soil Survey

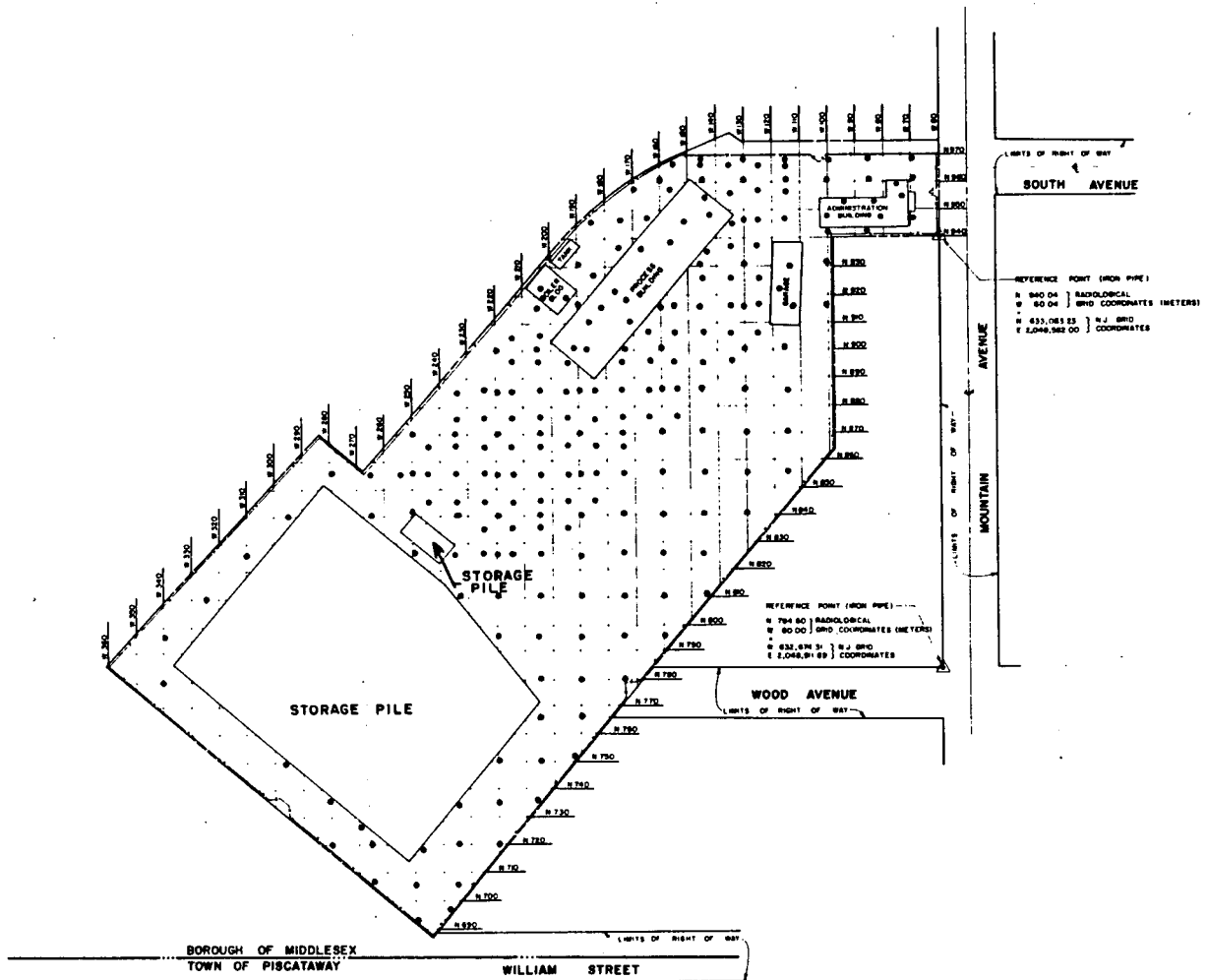
Prior to 1986, boreholes were drilled over the entire site on a 15-m (50-ft) grid as shown in Figure 8-2. On-site areas excluded from drilling were those under the storage piles located on the southern portion of the asphalt storage pad and a 0.6-m- (2-ft-) wide strip along the inside of the perimeter fence that had been excavated during earlier remedial action activities. The boreholes were drilled to the soil-shale interface, temporarily cased with a polyvinyl chloride tube, and gamma logged.

All soil samples (except for those around the administration building) will be considered subsurface samples in view of the thickness of asphalt covering the site. The majority of soil samples were analyzed on site for uranium-238, radium-226, and thorium-232 in the mobile laboratory. Table 8-3 shows the gamma spectrometry analysis results of soil samples from the asphalt-soil interface, and Table 8-4 shows the results of soil samples from borings.

All direct field survey measurements and laboratory results represent gross readings; background measurements and concentrations were not subtracted. Background levels applicable to Middlesex have been previously measured. Statewide New Jersey background soil concentrations in pCi/g have been measured as 0.86 for radium-226, 0.89 for thorium-232, and 0.87 for uranium-238.

Both beta-gamma dose rate measurements made at the ground-surface and near-surface gamma radiation measurements were used to define the areal extent of contamination. Beta-gamma dose rate measurements ranged from <0.01 to 7.25 mrad/h.

Elevated, near-surface gamma-radiation measurement readings are those that are equal to or greater than twice background. These readings would be, under normal circumstances, correlated with soil sample analysis to establish a calibration factor relating the detector's response in cpm to the specific radionuclide



LEGEND:

• BOREHOLE

NOT TO SCALE

FIGURE 8-2 BOREHOLE LOCATIONS AT THE FORMER MSP SITE

TABLE 8-3

GAMMA SPECTROMETRY ANALYSIS OF MSP SOIL SAMPLES FROM THE
ASPHALT/SOIL INTERFACE

Page 1 of 5

Coordinates		Concentration (pCi/g +/- 2 sigma)		
E,W	N,S	Uranium-238	Radium-226	Thorium-232
-85.00	945.00	--	0.8 ± 0.1	1.1 ± 0.3
-68.00	945.00	--	4.5 ± 0.3	0.7 ± 0.5
-190.00	930.00	56.6 ± 5.3	36.0 ± 0.9	--
-130.00	930.00	--	0.8 ± 0.2	0.9 ± 0.3
-108.00	930.00	--	0.5 ± 0.1	0.9 ± 0.2
-205.00	915.00	12.9 ± 2.6	9.8 ± 0.5	0.7 ± 0.5
-190.00	915.00	15.2 ± 3.2	11.2 ± 0.5	--
-160.00	915.00	--	1.4 ± 0.2	0.7 ± 0.2
-145.00	915.00	0.4 ± 0.9	0.5 ± 0.1	0.7 ± 0.2
-130.00	915.00	7.3 ± 2.4	8.1 ± 0.4	0.8 ± 0.5
-108.00	915.00	--	0.6 ± 0.2	0.7 ± 0.2
-220.00	900.00	6.7 ± 1.7	3.2 ± 0.3	0.3 ± 0.2
-205.00	890.00	10.7 ± 2.7	8.6 ± 0.5	1.0 ± 0.8
-160.00	900.00	1.3 ± 2.7	9.3 ± 0.5	6.6 ± 0.2
-150.00	900.00	5.8 ± 2.2	5.8 ± 0.4	0.6 ± 0.4
-115.00	900.00	3.8 ± 1.8	2.3 ± 0.2	--
-235.00	885.00	--	1.1 ± 0.2	1.9 ± 0.3
-220.00	885.00	1.5 ± 1.6	2.6 ± 0.2	1.0 ± 0.4
-205.00	885.00	4.2 ± 1.8	0.9 ± 1.7	0.6 ± 0.4
-190.00	890.00	8.8 ± 4.6	4.8 ± 0.3	0.5 ± 0.4
-175.00	885.00	98.7 ± 8.0	72.2 ± 1.3	0.5 ± 1.0
-160.00	885.00	91.5 ± 5.6	60.3 ± 1.2	--
-145.00	885.00	2.3 ± 1.4	1.6 ± 0.2	1.1 ± 0.3
-130.00	885.00	--	1.2 ± 0.1	1.2 ± 0.3
-115.00	885.00	3.5 ± 1.3	0.5 ± 0.1	1.3 ± 0.3
-247.50	870.00	1.7 ± 0.2	0.9 ± 0.2	1.2 ± 0.5
-235.00	870.00	419.6 ± 16.5	468.7 ± 3.7	--
-220.00	870.00	--	0.6 ± 0.2	1.4 ± 0.3
-205.00	870.00	1.2 ± 2.5	4.9 ± 0.4	0.5 ± 0.3
-190.00	870.00	0.9 ± 0.2	1.0 ± 0.2	0.5 ± 0.3
-175.00	870.00	6.3 ± 0.3	4.5 ± 0.3	0.9 ± 0.4
-162.50	870.00	2.6 ± 2.3	3.7 ± 0.3	0.5 ± 0.3
-145.00	870.00	9.9 ± 0.5	7.6 ± 0.5	0.9 ± 0.5
-130.00	870.00	12.1 ± 2.0	5.5 ± 0.3	0.5 ± 0.3
-115.00	870.00	--	0.3 ± 0.2	0.9 ± 0.5
-280.00	850.00	8.2 ± 2.0	2.1 ± 0.3	--
-262.50	855.00	1.3 ± 1.1	0.7 ± 0.1	--
-250.00	845.00	35.8 ± 5.5	35.2 ± 0.9	3.2 ± 0.8
-220.00	855.00	95.1 ± 6.4	50.4 ± 1.3	--
-205.00	855.00	31.2 ± 3.5	1.3 ± 0.4	19.3 ± 1.0
-190.00	855.00	961.4 ± 23.9	735.7 ± 5.4	--
-177.50	855.00	2.8 ± 2.0	2.6 ± 0.2	0.6 ± 0.3
-160.00	855.00	1.9 ± 1.8	2.4 ± 0.3	0.7 ± 0.5
-145.00	855.00	1.7 ± 1.1	0.4 ± 0.1	0.7 ± 0.3

TABLE 8-3
(continued)

Page 2 of 5

Coordinates		Concentration (pCi/g +/- 2 sigma)		
E,W	N,S	Uranium-238	Radium-226	Thorium-232
-130.00	855.00	1.8 ± 1.4	1.0 ± 0.2	1.3 ± 0.4
-115.00	855.00	5.2 ± 1.7	1.7 ± 0.3	0.8 ± 0.2
-295.00	840.00	--	0.4 ± 0.1	--
-265.00	840.00	1.2 ± 1.7	1.2 ± 0.2	0.7 ± 0.3
-250.00	840.00	1.6 ± 1.2	0.6 ± 0.1	0.7 ± 0.2
-235.00	840.00	33.4 ± 3.1	13.5 ± 0.6	1.1 ± 0.6
-220.00	840.00	10.3 ± 1.9	2.1 ± 0.3	0.7 ± 0.4
-205.00	840.00	28.2 ± 3.1	13.0 ± 0.6	1.4 ± 0.4
-190.00	840.00	2.6 ± 1.8	5.5 ± 0.3	1.0 ± 0.3
-160.00	840.00	--	1.0 ± 0.2	0.9 ± 0.3
-145.00	840.00	--	0.5 ± 0.2	1.3 ± 0.3
-130.00	840.00	--	0.7 ± 0.2	0.9 ± 0.2
-310.00	825.00	0.6 ± 1.0	0.8 ± 0.2	0.4 ± 0.2
-250.00	825.00	--	0.5 ± 0.1	0.4 ± 0.3
-235.00	825.00	--	0.2 ± 0.1	0.1 ± 0.2
-220.00	825.00	4.5 ± 0.3	3.8 ± 0.3	1.1 ± 0.3
-202.50	825.00	11.4 ± 2.0	3.2 ± 0.3	1.3 ± 0.4
-190.00	825.00	0.7 ± 1.7	1.0 ± 0.2	0.8 ± 0.2
-175.00	825.00	5.0 ± 1.9	2.6 ± 0.3	0.7 ± 0.3
-160.00	825.00	--	0.6 ± 0.2	1.1 ± 0.4
-325.00	810.00	2.9 ± 1.2	2.7 ± 0.2	--
-235.00	810.00	1.6 ± 1.6	2.1 ± 0.3	--
-215.00	810.00	33.8 ± 4.1	13.4 ± 0.7	0.5 ± 0.9
-205.00	810.00	9.9 ± 3.2	7.4 ± 0.4	0.9 ± 0.5
-190.00	810.00	3.6 ± 3.3	1.2 ± 0.2	--
-175.00	810.00	--	1.0 ± 0.2	0.3 ± 0.4
-160.00	810.00	--	1.6 ± 0.2	0.8 ± 0.3
-147.50	810.00	--	0.9 ± 0.2	0.8 ± 0.4
-340.00	795.00	1.2 ± 1.1	1.1 ± 0.2	0.4 ± 0.2
-215.00	795.00	1.9 ± 3.0	0.8 ± 0.2	1.1 ± 0.3
-207.50	795.00	--	0.3 ± 0.3	1.3 ± 0.2
-130.00	900.00	--	0.5 ± 0.2	1.3 ± 0.3
-175.00	795.00	4.2 ± 1.4	2.1 ± 0.2	1.1 ± 0.3
-160.00	795.00	--	0.7 ± 0.2	1.2 ± 0.3
-340.00	770.00	2.4 ± 1.9	5.9 ± 0.3	0.3 ± 0.3
-215.00	780.00	2.2 ± 1.0	0.7 ± 0.2	0.3 ± 0.3
-192.50	780.00	5.1 ± 1.8	0.9 ± 0.2	1.7 ± 0.4
-175.00	780.00	2.2 ± 0.9	0.4 ± 0.2	1.7 ± 0.3
-205.00	765.00	2.6 ± 1.7	1.0 ± 0.2	0.7 ± 0.3
-190.00	765.00	1.6 ± 2.0	1.4 ± 0.2	0.5 ± 0.2
-285.00	745.00	17.1 ± 5.5	21.8 ± 1.0	3.8 ± 1.0
-220.00	747.50	10.5 ± 1.5	2.9 ± 0.2	1.0 ± 0.3
-192.50	750.00	0.9 ± 1.7	0.5 ± 0.1	0.6 ± 0.2
-280.00	735.00	15.3 ± 10.9	687.0 ± 1.2	--
-235.00	735.00	7.8 ± 1.6	5.8 ± 0.4	0.8 ± 0.3
-220.00	735.00	2.3 ± 1.9	1.4 ± 0.2	--

5.0 GEOLOGY

5.1 TOPOGRAPHY

The MSP site slopes gently from approximately 18 m (60 ft) above mean sea level (msl) on the northern side to 15 m (50 ft) msl on the southern side. The highest point of the site is at the gate at the north end; the point gradually slopes to the fence line on the south end of the site.

5.2 GEOLOGY AND SOILS

Soils at MSP consist of silty or sandy loams ranging in thickness from 0.45 to 2.4 m (1.5 to 8 ft). All on-site surface water from the storage pile and adjacent areas is conveyed via an underground drainage system to a settling basin. Overflow from the settling basin is directed to the easement ditch south of the site that discharges into a small brook known as Main Stream, which flows west to Ambrose Brook, a tributary to the Raritan River.

Depth of the soil to bedrock on the site ranges from 0.45 to 2.4 m (1.5 to 8.0 ft). A zone of 0.3-m- (1-ft-) thick weathered bedrock is situated above the sound bedrock surface. The weathered zone is a red, cohesive, clayey silt with bedrock fragments, retaining little visible structure and corresponding to descriptions of Reaville soil. Above the weathered shale in Area A (Figure 5-1) is a layer of fill, which includes cinders, crushed stone, and gray silt. A geologic cross-section of Middlesex County is included in Figure 5-2.

The bedrock is red shale of the Brunswick formation. Thin coatings [5 mm (13 in.)] of nonmagnetic black material were found infrequently along fracture surfaces. Locations of boreholes are shown in Figure 5-3. Localized beds of gray-green shale were encountered in boreholes DOE-4A and DOE-5A. These beds were between 1 and 2 cm (0.4 and 0.8 in.) thick and occurred in clusters of up to four beds. In DOE-8 and DOE-5A, calcareous material occurred in

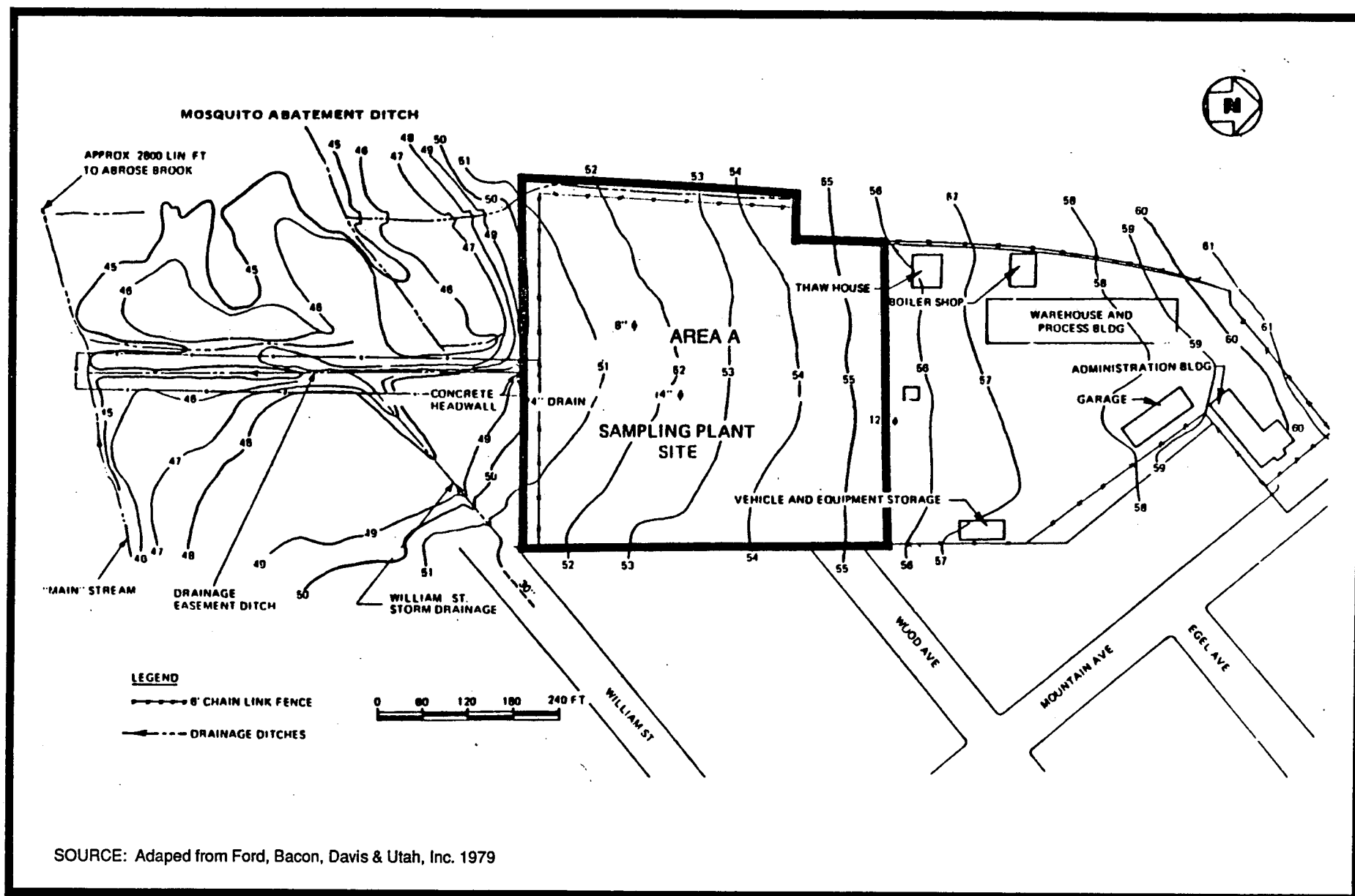


FIGURE 5-1 FORMER MSP SITE MAP

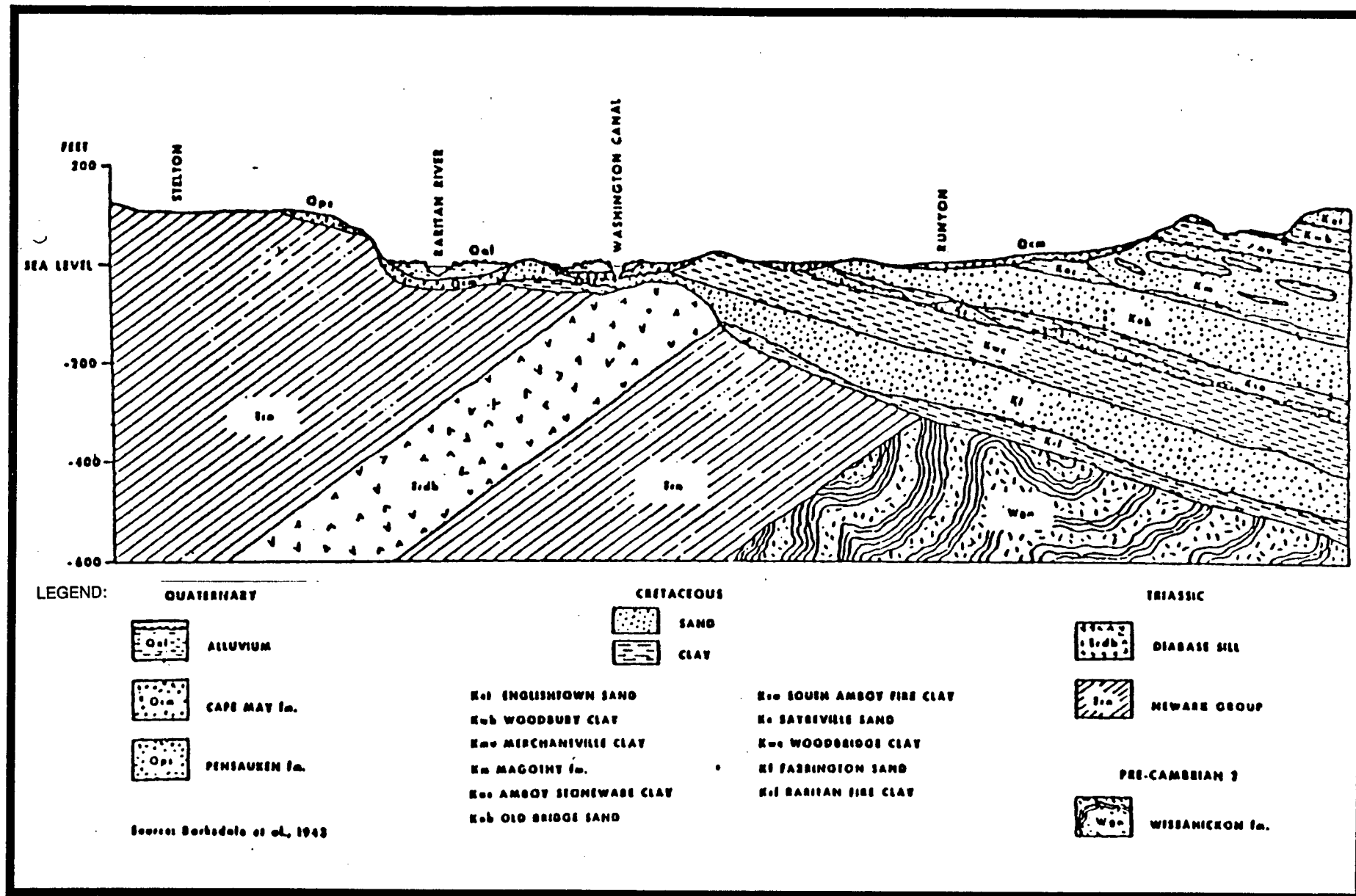


FIGURE 5-2 GENERALIZED GEOLOGIC SECTION —
MIDDLESEX COUNTY

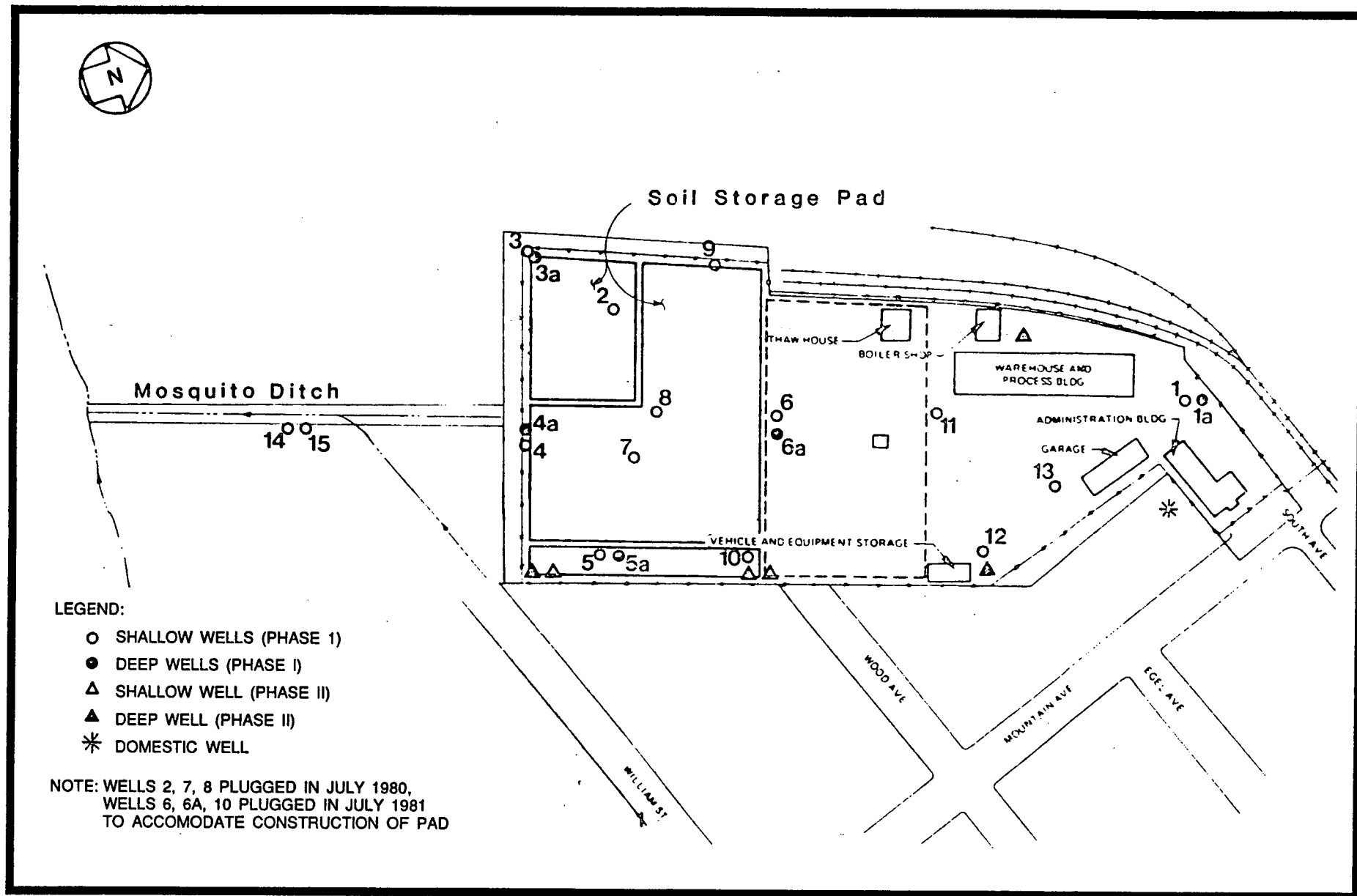


FIGURE 5-3 GROUNDWATER MONITORING WELLS AT MSP

zones approximately 1 cm (0.4 in.) thick; this material appears to have been deposited as joint filling. The calcareous zones occasionally exhibited small solution cavities. In DOE-5A, these zones were associated with the gray-green shale beds.

The shale commonly exhibited fissility, possibly induced by unloading fractures. There is no evidence that the fissile zones indicate pervasive, open fractures capable of transmitting water, except at DOE-6A. In this borehole, a 2.7-m (9-ft) zone of extremely fissile shale was encountered from 4.3 to 7 m (14 to 23 ft) below the surface. During drilling, air circulation was lost completely in this interval, indicating the development of an extensive open fracture. This fracture was confirmed in the slug test conducted at this borehole. Air circulation was not lost, nor was water encountered in any other boreholes located in zones of fissile shale.

6.0 HYDROLOGY

Middlesex County lies within two major physiographic provinces--the Atlantic Coastal Plain and the Piedmont Province. The portion of the county west of the Lawrence Brook and north of the Raritan River is generally within the Piedmont Province, and the remainder of the county is within the Atlantic Coastal Plain. The Piedmont Province is generally characterized by clay and shale formations with relatively high surface runoff rates, and the Atlantic Coastal Plain is characterized by sand and gravel formations with a higher infiltration rate.

The topography of Middlesex County is nearly level at some points and gently rolling at others, with maximum elevations of approximately 73.2 m (240 ft) msl in the southwestern part of South Brunswick Township. The lowest elevations approach sea level at the tidal areas on Raritan Bay and at the mouth of the Raritan River. As a result of its natural topography and its proximity to Raritan Bay, the county contains numerous natural drainage ways, the majority of which drain to the Raritan River and ultimately into Raritan Bay (Figure 6-1). Streams in the eastern area of the county drain directly to the Raritan Bay, and several in the northeastern portion of the county are tributaries of the Rahway River or drain directly to the Arthur Kill.

6.1 SURFACE WATER

The quality of the surface waters in Middlesex County varies, but the major streams are generally not suitable for potable water. The Middlesex Water Company has diversion rights on the Raritan River downstream from the MML site, but the utility is not using these rights; it prefers instead to obtain water from the Delaware-Raritan Canal.

Figure 6-1 shows the major drainage basins in the vicinity of MSP. Figure 6-2 shows the surface water sampling locations and drainage near MSP.

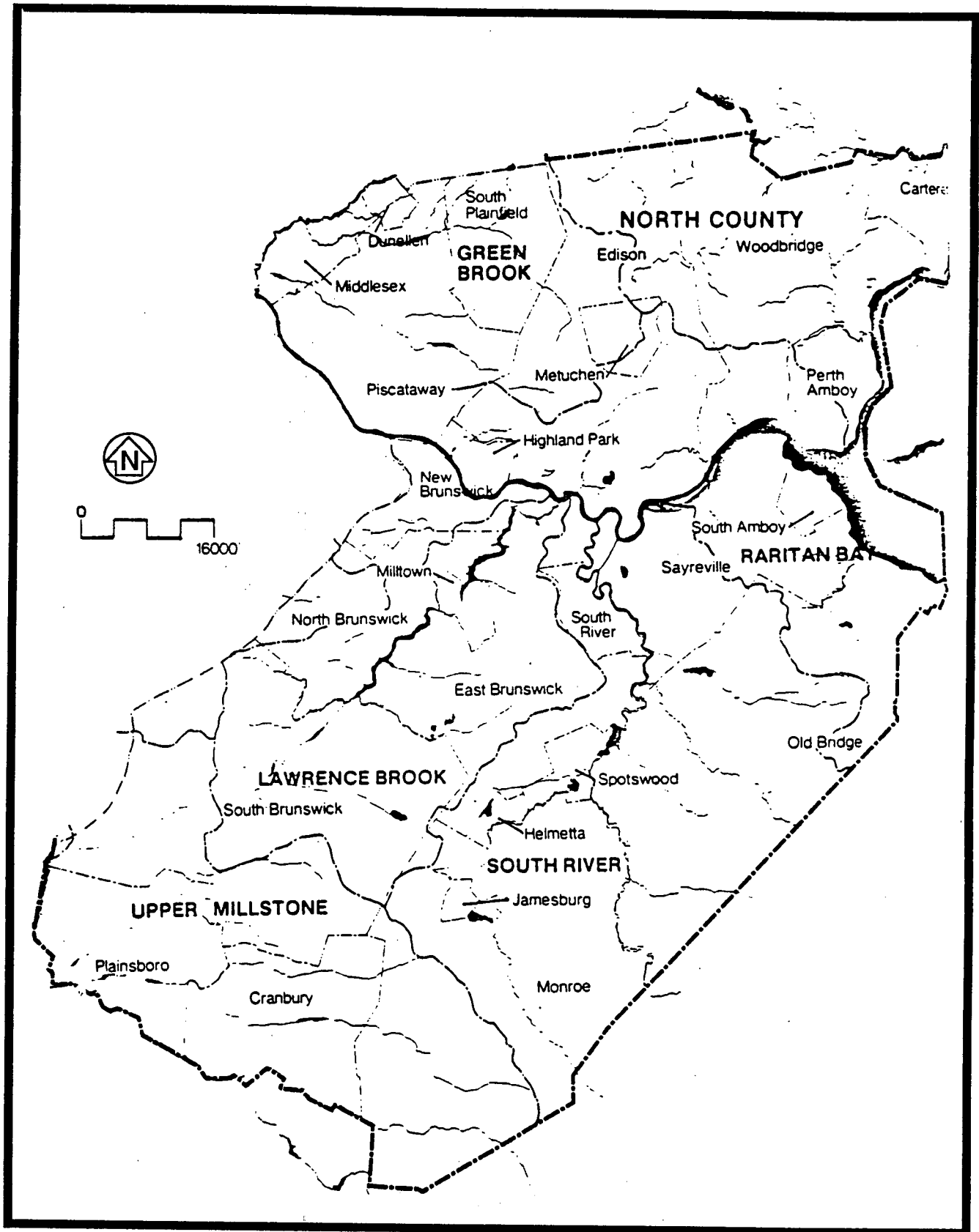


FIGURE 6-1 MAJOR DRAINAGE BASINS — MIDDLESEX COUNTY

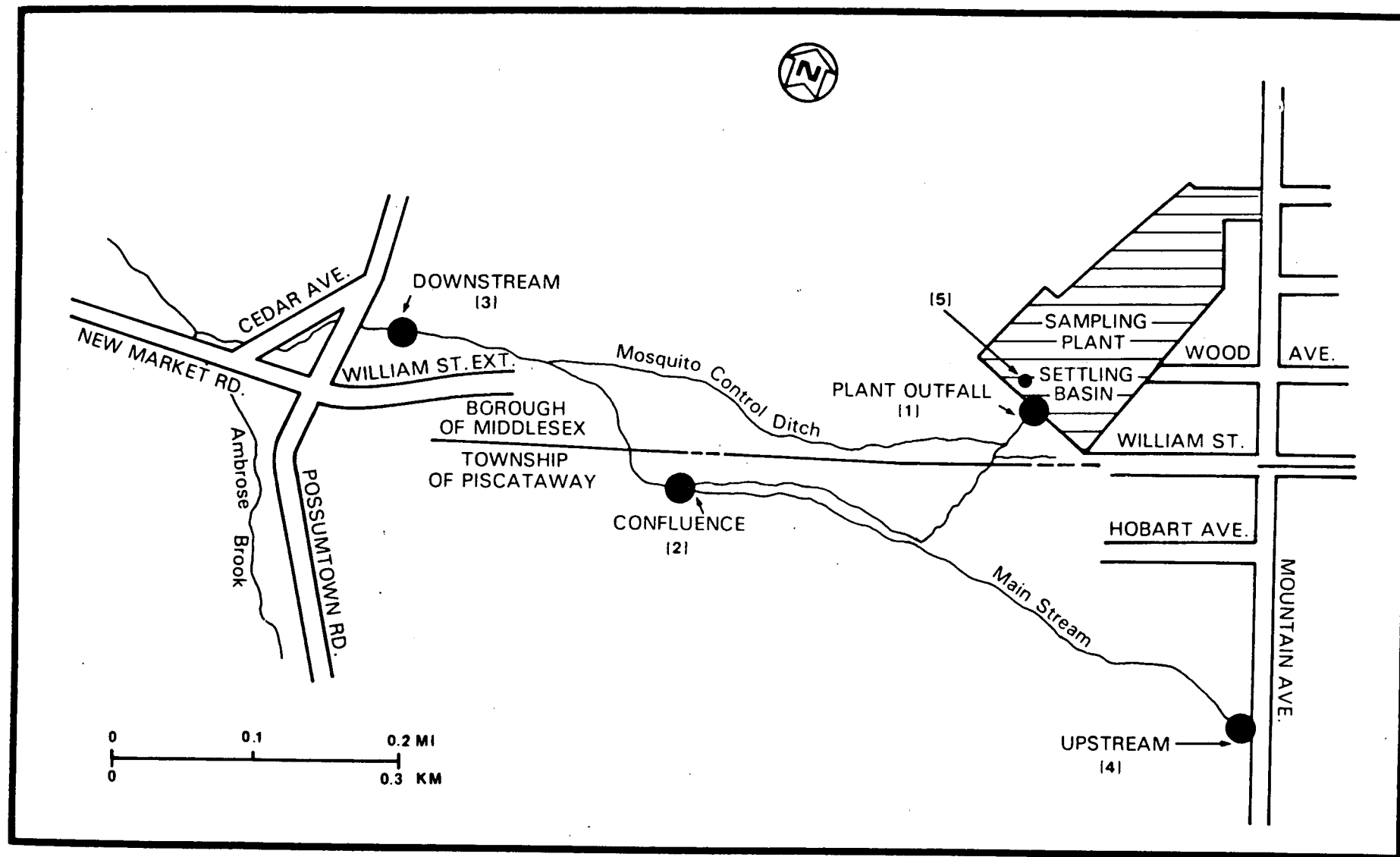


FIGURE 6-2 SURFACE WATER SAMPLING LOCATIONS AND DRAINAGE NEAR THE MSP SITE

Surface water samples collected at MSP from 1980 through 1987 showed a range of uranium-238 concentrations from 1.5 to 234 pCi/L and a range of radium-226 concentrations from 0.01 to 100 pCi/L at various sampling locations.

6.2 GROUNDWATER

Groundwater occurs in the secondary porosity of the Brunswick Formation as a result of fractures. The fracture-flow system offers little natural filtration and purification once water reaches the formation. The Brunswick Formation is a major aquifer in the western part of Middlesex County and adjoining Essex County. A number of private water supply wells are located within 1.6 km (1 mi) of MSP. These wells are shown in Figure 6-4. A public well field, Sebrings Mill Well Field, is located 2 km (1.25 mi) northwest of MSP. The Elizabethtown Water Company Sebrings Mill Well Field (Figure 6-4) supplies as much water as 1.3 mgd.

Roy F. Weston was contracted by Union Carbide Corporation to assess the subsurface soil and groundwater conditions at the portion of the MSP designated as Area A, shown in Figure 5-1. Weston's field program included the following activities:

- o Completion of 15 boreholes to bedrock and five boreholes into bedrock
- o Collection of split-spoon samples or core samples to provide a geologic log of each borehole
- o Permeability measurements using slug tests in shallow and deep boreholes
- o Examination of soil samples from split-spoon samples
- o Radiologic logging of each borehole to determine the activity present in the soil and bedrock

In addition, a number of samples of representative soil, bedrock, and groundwater were collected and analyzed for radium-226, uranium-238, thorium-232, gross alpha, and gross beta.

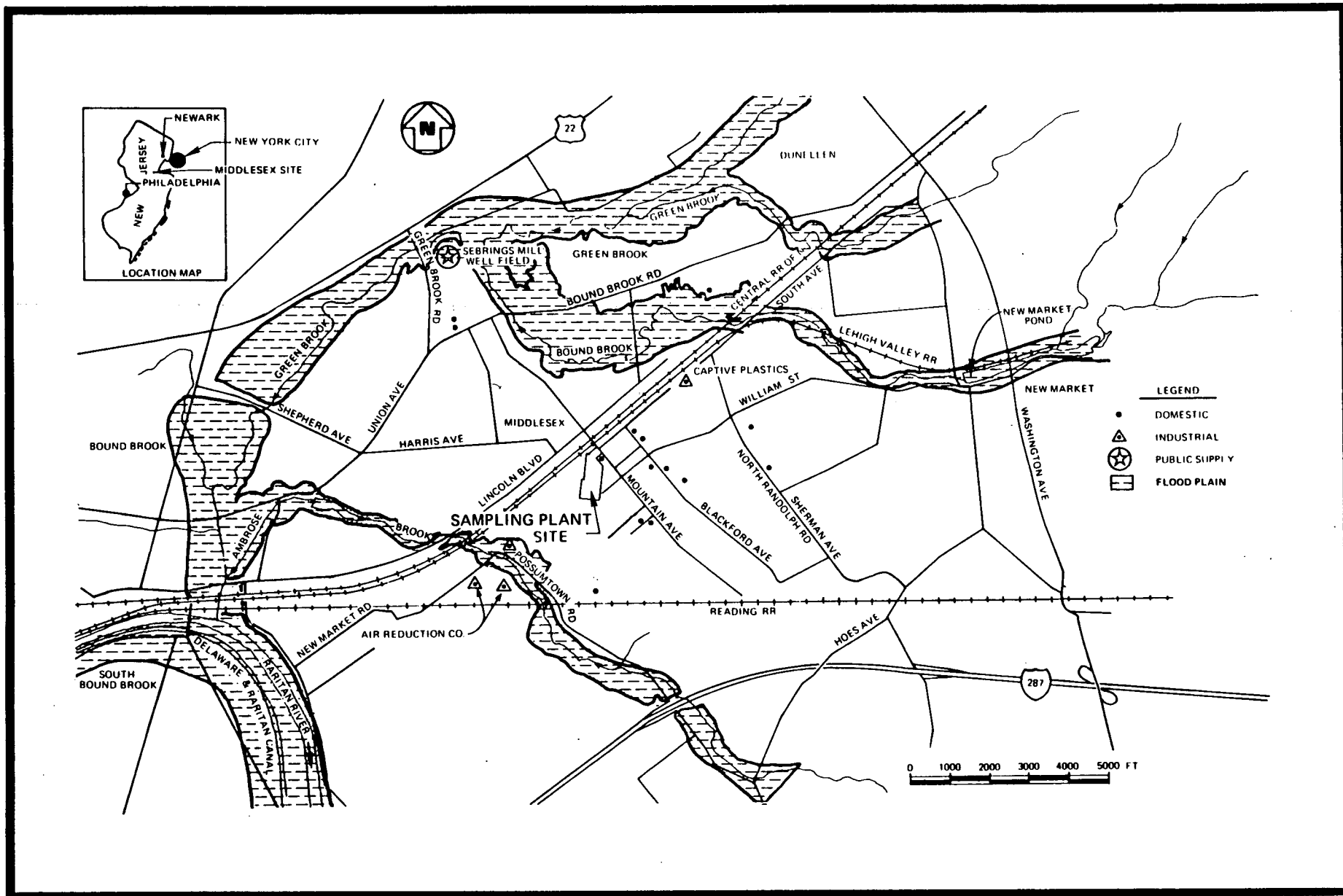


FIGURE 6-3 FLOODPLAINS AND APPROXIMATE LOCATION OF WELLS IN VICINITY OF MSP

The data collected during the field activities, beginning in May 1980 and concluding in early August 1980, were used to define the groundwater flow system at the site. Water level elevations for 1980 are shown in Table 6-1. Precipitation data for the period of measurement are shown in Table 6-2. Figure 5-3 shows the locations of the groundwater monitoring wells. Figures 6-5 and 6-6 show groundwater contours using data collected from the shallow and deep wells in 1988.

With the exceptions of DOE-3, DOE-7, and DOE-9, water levels in all boreholes rose between June 10 and July 2, 1980. The most reasonable explanation for these fluctuations is disruption of the drainage system by site preparation and construction activities. Preparation of the site for the construction of the new asphalt pad began during the first week of July. Site preparation involved the removal of the subsurface drainage system with the attendant excavation as well as removal of the paving over most of Area A. Prior to the beginning of site preparations, the silty clay soil above the bedrock presented a low-permeability barrier to the vertical flow of water from the near surface to bedrock. In removal of the drainage system, that barrier was disturbed.

These changes in drainage patterns were apparently local and did not affect the flow of groundwater under the site.

6.2.1 Shallow Groundwater

Groundwater in the shallow system is approximately 3.0 m (10 ft) below the surface and has a low-flow velocity. Low transmissivity, determined in slug tests on DOE-8 and DOE-12 and the low hydraulic gradient [0.3 m/18 m (1 ft/60 ft)], are indicative of a low-groundwater flow velocity. The shallow boreholes were cased and screened through the parking lot subbase; therefore, the low transmissivity is representative of weathered shale and silty fill material and does not reflect the effect of the more permeable coarse-grained fill material. Flow is in a southerly direction. A minor flow component is to the northeast toward DOE-13.

TABLE 6-1
GROUNDWATER ELEVATIONS AT THE MSP SITE, 1980

Boring	Elevation in ft above msl				
	6/18/80	7/2/80	7/10/80	7/22/80	7/31/80
DOE 1	51.73	53.68	54.00	53.35	53.85
DOE 1A	46.42	47.46	47.06	44.32	47.00
DOE 2	49.02	49.33	48.17	Paved Over	--
DOE 3	49.23	49.02	47.51	48.78	48.95
DOE 3A	46.90	47.20	47.30	47.24	47.10
DOE 4	44.19	44.75	44.96	44.97	45.58
DOE 4A	43.00	43.19	43.23	43.60	43.60
DOE 5	46.50	46.82	46.72	45.39	47.80
DOE 5A	27.93	27.65	27.73	29.20	-a-
DOE 6	51.10	51.28	51.22	50.45	51.64
DOE 6A	36.12	36.34	36.26	36.47	41.42
DOE 7	47.96	47.95	47.83	Paved Over	--
DOE 8	48.92	49.10	49.04	Paved Over	--
DOE 9	51.91	51.76	52.71	54.73 ^b	54.73 ^b
DOE 10	50.03	50.74	50.70	50.52	Paved Over
DOE 11	52.72	53.82	53.41	52.29	53.50
DOE 12	52.95	54.06	53.50	52.40	53.63
DOE 13	51.58	52.32	51.72	52.80	54.41
DOE 14	43.51	43.77	43.62	43.22	43.59
DOE 15	44.61	44.76	44.65	44.57	44.80

^aWell 5A--Block in the casing.

^bWell 9--Cap had been removed.

TABLE 6-2
DAILY PRECIPITATION RECORDED AT
NEWARK INTERNATIONAL AIRPORT^a

Date	Precip. Recorded (in.)	Date	Precip. Recorded (in.)
June 12	0	July 9	0
13	0	10	0
14	0	11	Trace
15	0.04	12	Trace
16	0	13	0
17	0	14	0
18	0	15	Trace
25	0	16	0.09
26	0	17	0.03
27	0	18	0
28	0	19	0
29	1.20	20	0
30	0.02	21	0.43
July 1	0	22	0.02
2	0.04	23	0
3	0.01	24	0
4	0	25	0
5	0.23	26	Trace
6	0	27	0
7	0	28	Trace
8	Trace	29	1.93
		30	0
		31	Trace

^aMeasurements taken in 1980.

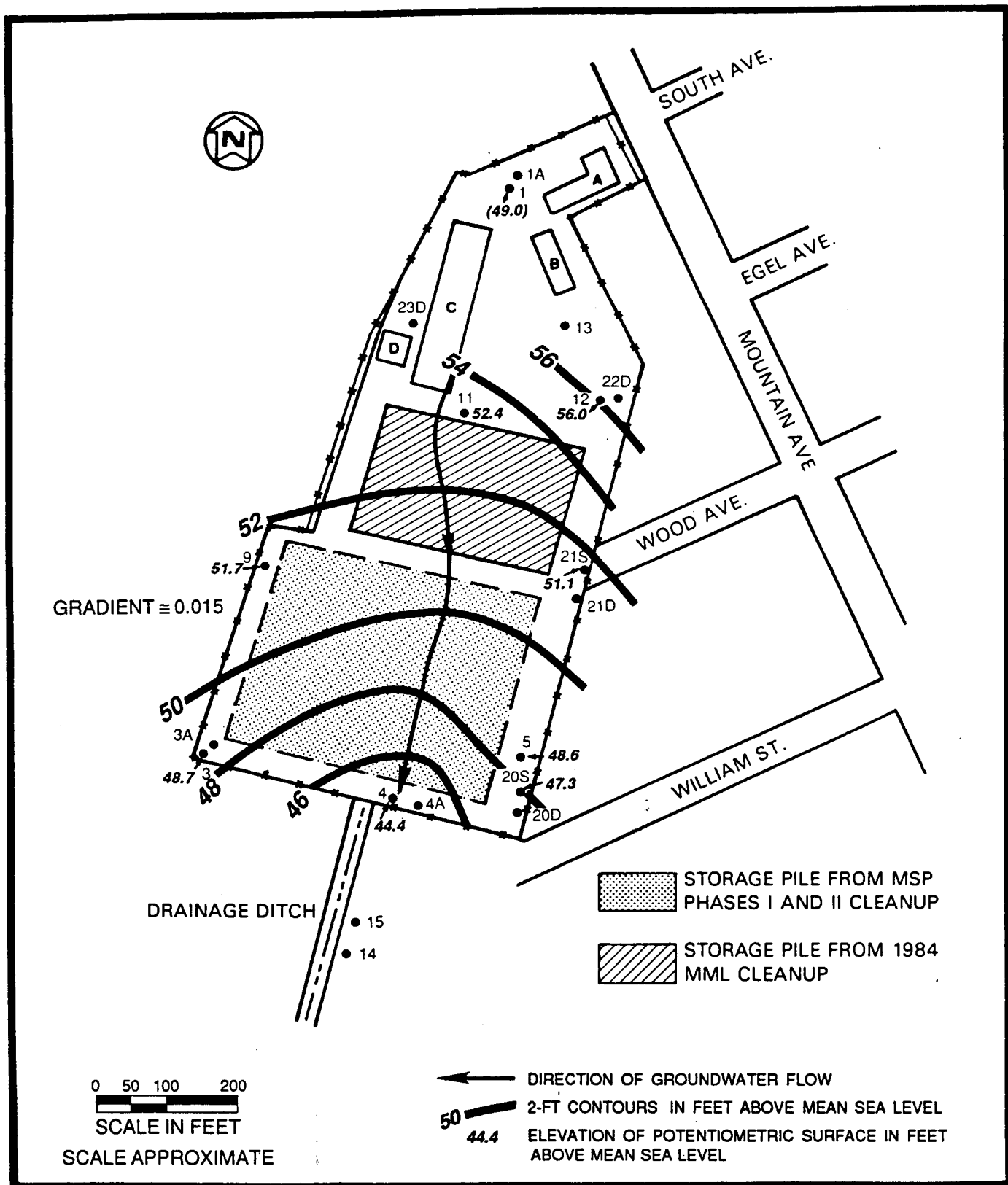


FIGURE 6-4 MSP GROUNDWATER POTENTIOMETRIC SURFACE — SHALLOW WELLS (3/28/88)

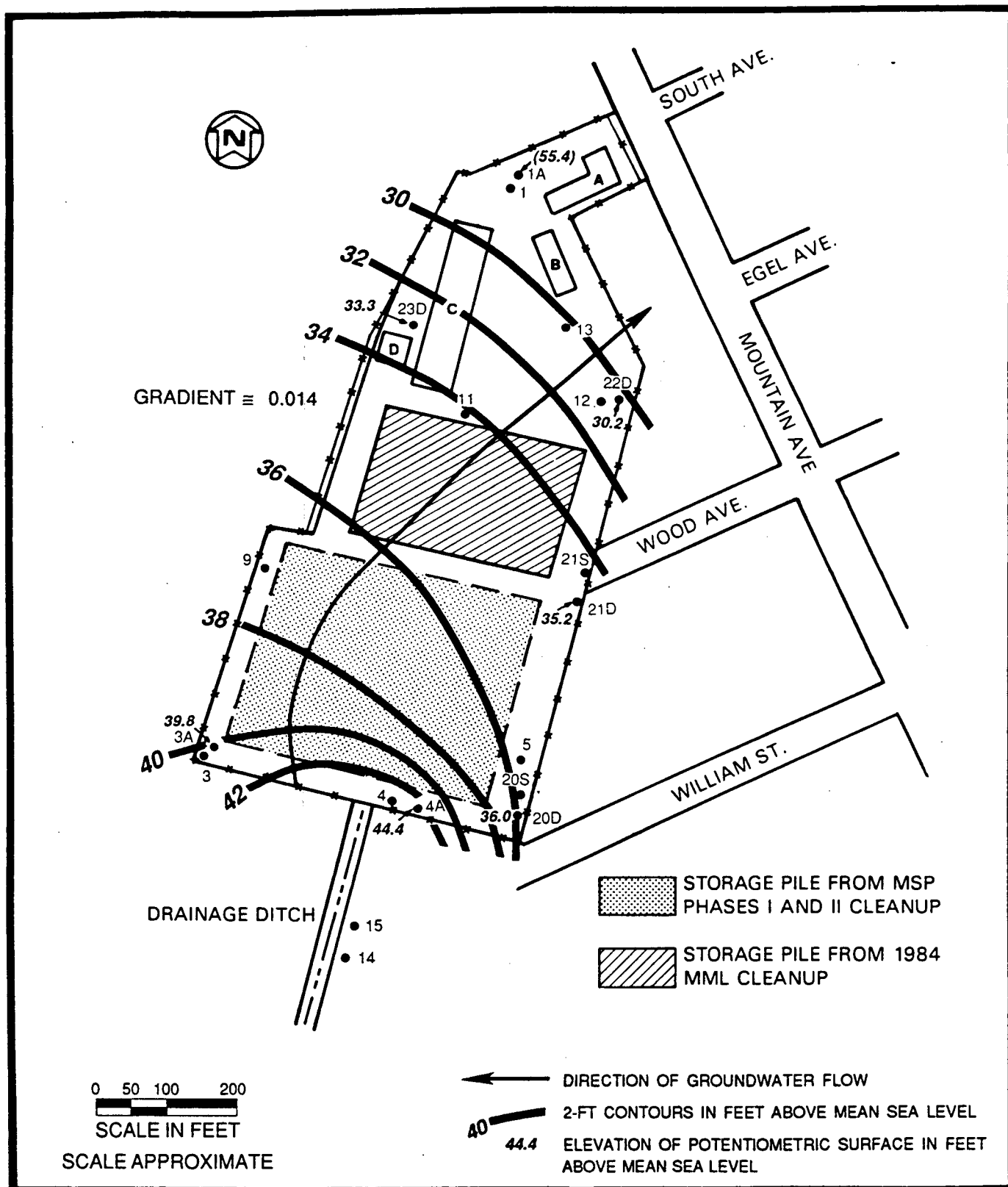


FIGURE 6-5 MSP GROUNDWATER POTENTIOMETRIC SURFACE — DEEP WELLS (3/24/88)

6.2.2 Bedrock Groundwater

The calcareous zones and solution cavities observed in the core samples along with the changes in drilling characteristics suggest an increase in transmissivity at the 4.6- to 7.6-m (15- to 25-ft) depth in the deeper boreholes. The slug tests performed in the deep boreholes corroborate the increase in transmissivity.

The bedrock aquifer also shows a steeper groundwater hydraulic gradient [0.3 m/2.7 m (1 ft/9 ft)], which, coupled with the higher transmissivity, is indicative of a higher groundwater flow velocity. Flow in the bedrock system is toward the east. Figure 6-6 indicates that flow is toward the Wood Avenue gate. It is possible that this is an artificial trend since this interpretation is dependent on the water level in DOE-6A, which encountered a major fracture. The limited number of deep borings made individual water levels important in the interpretation of the potentiometric surface contours.

The transmissivity values for the deep borings are given below.

<u>Boring No.</u>	<u>Transmissivity (gpd/ft)</u>
DOE-1A	69
DOE-4A	73
DOE-5A	105
DOE-6A	115
DOE-8	7
DOE-12	22

Transmissivity determined at DOE-6A was the highest and, during drilling of DOE-6A, was the only borehole that showed a significant open fracture; therefore, the high transmissivity was expected. Transmissivity at DOE-5A was close to that at DOE-6A, although a major open-fracture zone was not encountered during drilling. However, a minor fracture was noted at the 7.3- to 7.6-m (24- to 25-ft) depth. In addition, DOE-5A also encountered a large number

of calcareous joint fillings from approximately 6.1 m (20 ft) below the surface to the bottom of the boring. Although thin and apparently not laterally extensive, these zones appeared to be quite open as a result of dissolution of the calcareous material. This would account for the high transmissivity resulting from the slug test.

Weston reports that, based on examination of the samples taken during drilling and the results of slug tests on DOE-1A and DOE-4A, a transmissivity of approximately 97 Lpd/m (70 gpd/ft) is representative of the on-site bedrock, except where open fractures are encountered.

7.0 STORAGE PILE CONSTRUCTION

As part of the remedial actions performed by NLO, an 11,100-m² (120,000-ft²) asphalt pad was constructed in the storage area. Because of the poor condition of the old pavement, a 2.5-cm (1-in.) leveling course of bituminous concrete was initially applied to the storage pile area. Then the 3.8-cm (1.5-in.) hot-mix bituminous-concrete top course, underlaid with a nonwoven paving grade polypropylene fabric, was subsequently installed over the asphalt-leveling course and rolled to achieve 95 percent Marshall density.

A 1.5-mm (60-mil) standard nylon-reinforced ethylene propylene diene monomer, manufactured by Carlisle Tire and Rubber, was installed as a cover for the contaminated materials. First, a 1-m- (3-ft-) wide perimeter tuck piece was bonded to the asphalt pad with cement. The edge pieces and border timbers were then spliced, cemented, and bolted together. The remainder of the liner was then put in place. Each lap splice was cleaned with unleaded gasoline prior to applying the jointing cement, according to the manufacturer's instructions. A minimum 15-cm (6-in.) lap was maintained for every splice. Upon completion of the splice, a lap sealant was applied to improve the integrity of the cemented-lap splice.

A different storage pile construction was employed for the waste from remedial action performed by BNI. A 45.7-cm- (18-in.-) high concrete curb was constructed around the perimeter of the storage area, and 15.2 cm (6 in.) of silty sand was placed within it to form a smooth, graded base. A 0.91-mm (36-mil) geomembrane liner was then placed on the sand and lapped up and attached to the top of the curb with battens. A 15.2-cm (6-in.) layer of permeable sand was then spread over the geomembrane to act as a leachate collection system, and contaminated material placement began. As portions of the storage area were completed, they were covered with a geomembrane stockpile cover. The battens attaching the bottom liner to the curbs were removed; the cover and liner were sealed together; and the battens were reinstalled. The wastes were thus completely

encapsulated by the geomembrane liner and cover. A sump riser was installed at the lower end of the storage pile to allow removal of any leachate that might collect in the collection system.

The collection system was provided only to collect any water that exceeded the moisture-holding capacity of the material that was present in the contaminated material when the storage piles were constructed. If leachate is generated, it is collected by a commercial wastewater treatment facility for off-site treatment and disposal. No on-site treatment will take place. Approximately, 909 L (200 gal) of wastewater was removed from the leachate collection system after the piles were covered. No wastewater has been collected since, and none is anticipated.

8.0 SUMMARY OF CONTAMINATION

8.1 ORNL SURVEY

During 1976, a radiological survey of MSP was conducted by the Oak Ridge National Laboratory (ORNL). During this survey, measurements of activity were made in buildings and soil, and external gamma radiation levels were determined. Groundwater was not sampled.

8.1.1 Soil Survey

Soil samples were collected at 46 locations on the site and at 2 background locations. One of the background samples was collected in sandy soil across Mountain Avenue from the Municipal Building; the other sample was collected in the same type of soil that occurs at the site at the corner of Lincoln and Mountain Avenues. On-site radium-226 concentrations ranged from 0.8 to 477 pCi/g, compared with background levels of 1.0 pCi/g and 1.7 pCi/g. The highest concentration of radium-226 (2401 pCi/g) was found in the drainage ditch south of the site.

Examination of these data shows that, with the exception of 4 locations, radium-226 concentrations did not exceed 5 pCi/g below a depth of 0.6 m (2 ft). These locations are immediately west and south of the Process Building shown in Figure 3-1; the laboratory was located in this building. The maximum radium-226 concentration was 57 pCi/g at a depth of from 1.2 to 1.5 m (4 to 4.8 ft). It is likely that the elevated concentrations of radium-226 resulted from accidental spillage and discharges from the waste disposal system of the building.

8.1.2 Summary of ORNL Survey

In summary, the ORNL survey showed that contamination near the surface was widespread throughout the site and was more prevalent in the vicinity of the Process Building. Changes in radium-226

concentrations were abrupt, both laterally and vertically. Background concentrations for radium-226 in groundwater were 0.29 pCi/L.

8.2 WESTON SURVEY

During the Weston evaluation of the groundwater for ORNL in 1980, a radiological investigation was conducted. This investigation consisted of three elements:

- o Radiological logging of all boreholes
- o Analysis of soil and rock samples from the boreholes
- o Analysis of groundwater samples

The results of rock and soil sample analyses are presented in Table 8-1; results of groundwater analyses are presented in Table 8-2.

8.2.1 Subsurface Soil and Rock Survey

Figure 8-1 is a graph developed by Radiation Management Corporation, based on the samples collected at MSP, which provides a correlation between counts per minute (cpm) and radium-226 concentration. Based on this figure, it can be stated that 40,000 cpm is generally indicative of a radium-226 concentration over 5 pCi/g. Only two boreholes, DOE-2 and DOE-6, displayed activity above 40,000 cpm. This level of activity occurred in the upper 0.9 m (3 ft) in DOE-2 and throughout DOE-6. Note that in DOE-6A, which is within 3.0 m (10 ft) of DOE-6, activity was an order of magnitude less.

TABLE 8-1

MSP REMEDIAL DECONTAMINATION PROJECT

SOLID SAMPLE ANALYSIS RESULTS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		Ra-226	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A Initial Site)	31387	341.	11	205.	10	44.0	10
DOE-1A #1 (Red Clay)	31389	14.5	64	38.2	13	0.734	17
DOE-1A #2 (Red Clay)	31388	32.2	39	41.5	12	3.54	10
DOE-2 Site (Asphalt)	31382	—	—	—	—	17.0	10
DOE-2 #1 (Fill Dirt)	31396	51.0	32	33.8	14	5.75	10
DOE-2 #2 (Red Clay)	31391	19.7	53	41.7	12	0.568	23
DOE-2 #3 (Subfill 1)	31393	29.1	42	27.8	16	4.99	10
DOE-2 #3 (Subfill 2)	31394	11.4	75	20.0	20	0.618	20
DOE-2 (Core 2.5-3.5 ft)	33917	38.2	33	32.7	12	—	—
DOE-2 (Core 4.0-5.0 ft)	33918	18.7	50	30.3	12	—	—
DOE-3A #1 (Sludge)	31385	18.4	54	26.9	15	0.590	22
DOE-4 #1 (Red Clay)	32768	9.38	73	23.5	17	1.05	16
DOE-5 #1 (Auger Soil)	32769	12.5	62	27.6	15	0.696	21
DOE-5 (Core 5.0-5.5 ft)	33919	<4.9	—	21.2	16	—	—
DOE-5A #1 (Red Clay)	31392	14.6	64	28.1	16	0.761	19
DOE-6 (Core 1.0-2.5 ft)	33921	212.	13	185.	10	—	—
DOE-6 (Core 2.5-4.3 ft)	33922	63.4	25	42.7	10	—	—
DOE-6 (Core 4.3-6.0 ft)	33923	6.38	10	4.94	10	—	—
DOE-6 (Core 6.0-7.5 ft)	33924	2.47	43	2.43	15	—	—
DOE-6A #1 (Gray Mud)	31395	1.77	63	2.36	18	2.02	11
DOE-6A #2 (Red Clay)	31390	1.45	64	2.73	15	0.575	21
DOE-7 #1 (Auger Soil)	32770	4.74	30	7.99	10	1.95	12
DOE-7 (Core 3.0-5.0 ft)	33930	5.14	30	7.78	10	—	—
DOE-8 #1 (Tailings)	32771	2.19	43	2.30	18	3.02	10
DOE-10 #1 (Subasphalt)	32765	1.31	10	2.42	10	793.	10
DOE-11 #1 (Auger Soil)	32766	2.20	49	3.77	12	14.7	10
DOE-13 #1 (Auger Soil)	32767	9.93	20	8.66	10	1.98	12
DOE-14 (Core 0.5-1.5 ft)	33935	7.52	23	6.25	10	—	—
DOE-14 (Core 3.5-4.0 ft)	33936	2.25	45	3.81	11	—	—

TABLE 8-1
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	52.3	9	2.06	23	54.9	9
DOE-1A #1 (Red Clay)	31389	1.03	28	0.063	—	0.611	38
DOE-1A #2 (Red Clay)	31388	1.69	15	0.182	44	1.40	16
DOE-2 #1 (Fill Dirt)	31396	10.2	11	0.420	43	1.04	11
DOE-2 #2 (Red Clay)	31391	0.897	33	<0.14	—	0.874	34
DOE-2 #3 (Subfill 1)	31393	18.6	12	<0.56	—	18.2	17
DOE-2 #3 (Subfill 2)	31394	1.07	25	0.061	—	0.548	33
DOE-4 #1 (Red Clay)	32768	1.22	23	<0.14	—	1.33	23
DOE-5 #1 (Auger Soil)	32769	5.38	15	<0.21	—	4.04	17
DOE-6A #1 (Gray Mud)	31395	3.27	6	0.225	52	2.75	16
DOE-6A #2 (Red Clay)	31390	0.560	38	0.057	—	0.618	36
DOE-7 #1 (Auger Soil)	32770	2.30	17	0.080	—	2.00	20
DOE-8 #1 (Tailings)	32771	4.80	13	0.187	54	4.39	13
DOE-10 #1 (Subasphalt)	32765	329.	11	<0.21	285.	33	
DOE-11 #1 (Auger Soil)	32766	6.59	14	0.289	52	7.07	13
DOE-13 #1 (Auger Soil)	32767	17.0	9	0.412	38	16.5	10

TABLE 8-1
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/g)	Percent Uncertainty	Concentration (pCi/g)	Percent Uncertainty
DOE-1A (Initial Site)	31387	490.	20	9.18	42
DOE-1A #1 (Red Clay)	31389	50.1	62	9.19	48
DOE-1A #2 (Red Clay)	31388	7.52	24	3.62	33
DOE-1A #3 (Sludge)	31386	8.46	30	6.07	35
DOE-2 #1 (Fill Dirt)	31396	63.2	20	6.28	40
DOE-2 #2 (Red Clay)	31391	5.26	44	8.24	37
DOE-2 #3 (Subfill 1)	31393	164.	21	7.32	49
DOE-2 #3 (Subfill 2)	31394	4.66	52	7.67	43
DOE-4 #1 (Red Clay)	32768	13.1	34	8.59	37
DOE-5 #1 (Auger Soil)	32769	4.13	44	6.37	37
DOE-6A #1 (Gray Mud)	31395	22.2	27	5.78	43
DOE-6A #2 (Red Clay)	31390	3.04	56	5.21	44
DOE-7 #1 (Auger Soil)	32770	7.85	32	4.93	39
DOE-8 #1 (Tailings)	32771	50.3	24	14.1	32
DOE-10 #1 (Subasphalt)	32765	2690.	16	6.70	37
DOE-11 #1 (Auger Soil)	32766	58.4	22	6.31	43
DOE-13 #1 (Auger Soil)	32767	111.	18	5.57	39

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey—Final Report, October 1980.

TABLE 8-2

MSP GROUNDWATER QUALITY ANALYSIS

Page 1 of 3

Boring No.	RMC No.	Gross Alpha		Gross Beta		Ra-226	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	56.3	21	<2.3	—	0.439	45
DOE-3A	32755	49.5	21	16.2	18	0.729	36
DOE-4	32760	4.54	75	3.98	62	0.237	57
DOE-4A	32757	11.2	44	58.7	10	0.450	56
DOE-5	32761	8.82	53	8.56	32	0.118	94
DOE-5A	32758	<1.8	—	20.0	17	0.187	91
DOE-6 7/3/80	32762	2740.	10	432.	10	474.	10
DOE-6A 7/3/80	32759	6.47	75	<2.4	—	0.219	70
DOE-6 7/31/80	35788	3050.	10	—	—	—	—
DOE-6A 7/31/80	35805	13.5	50	15.9	18	—	—
DOE-8	32763	66.7	19	15.6	20	1.94	20
DOE-9	35789	17.3	28	6.27	10	—	—
DOE-11	35790	4.19	60	4.33	51	—	—
DOE-12	35791	<1.48	—	<2.02	—	—	—
DOE-13	35792	<1.83	—	130.0	10	—	—
DOE-14	32764	5.99	75	<2.30	—	—	26

TABLE 8-2
(continued)

Page 2 of 3

Boring No.	RMC No.	U-234		U-235		U-238	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-1A	32754	6.36	24	<0.54	64	4.44	28
DOE-3A	32755	21.2	15	0.93		18.9	15
DOE-4	32760	0.655	10	<0.45		0.940	63
DOE-4A	32757	10.4	19	<0.70		12.0	18
DOE-5	32761	6.34	25	<0.27		5.24	27
DOE-5A	32758	1.77	45	<0.58	50	1.06	58
DOE-6	32762	1420.	10	<54.0		1430.	10
DOE-6A	32759	4.72	28	<0.57		2.45	38
DOE-8	32763	38.6	12	1.46		41.3	11
DOE-14	32764	1.98	43	<0.27		2.97	35

TABLE 8-2
(continued)

Page 3 of 3

Boring No.	RMC No.	Th-230		Th-232	
		Concentration (pCi/L)	Percent Uncertainty	Concentration (pCi/L)	Percent Uncertainty
DOE-3A	32755	6.98	40	9.08	36
DOE-4	32760	<4.5	--	<1.5	--
DOE-4A	32757	31.6	41	<5.5	--
DOE-5	32761	<9.0	--	<3.4	--
DOE-5A	32758	5.95	52	10.5	41
DOE-6	32762	115.	24	<5.3	--
DOE-6A	32759	<8.8	--	<5.4	--
DOE-8	32763	<4.7	--	<10.	--
DOE-14	32764	13.8	73	<5.2	--

Source: Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Site,
Middlesex, New Jersey--Final Report, October 1980.

TABLE 8-3
(continued)

Page 3 of 5

Coordinates		Concentration (pCi/g +/- 2 sigma)		
E,W	N,S	Uranium-238	Radium-226	Thorium-232
-210.00	740.00	208.9 ± 8.2	48.5 ± 1.2	--
-280.00	717.50	--	1.0 ± 0.2	1.7 ± 0.7
-265.00	720.00	2.9 ± 2.1	1.2 ± 0.3	0.5 ± 0.4
-235.00	720.00	4.7 ± 2.6	0.9 ± 0.3	1.4 ± 0.4
-220.00	720.00	5.1 ± 0.9	0.8 ± 0.1	0.9 ± 0.2
-260.00	710.00	--	1.3 ± 0.3	0.9 ± 0.5
-250.00	705.00	33.2 ± 2.7	1.2 ± 0.2	1.0 ± 0.3
-250.00	705.00	5.2 ± 1.9	1.2 ± 0.3	0.5 ± 0.4
-235.00	695.00	0.5 ± 1.4	0.7 ± 0.1	--
-267.50	731.00	2.8 ± 1.7	0.8 ± 0.2	0.3 ± 0.3
-170.00	777.50	86.9 ± 4.6	6.0 ± 0.4	1.1 ± 0.6
-185.00	945.00	307.6 ± 9.9	45.4 ± 1.2	--
-125.00	915.00	5.5 ± 0.4	6.8 ± 0.5	1.2 ± 0.5
-135.00	915.00	--	6.0 ± 0.5	--
-142.50	925.00	--	1.1 ± 0.3	1.6 ± 0.6
-125.00	925.00	--	1.0 ± 0.3	1.8 ± 0.4
-235.00	705.00	73.5 ± 4.9	50.7 ± 1.2	3.8 ± 1.0
-235.00	855.00	15.4 ± 4.7	7.2 ± 0.6	2.1 ± 0.7
-250.00	720.00	21.9 ± 3.4	1.7 ± 0.3	2.1 ± 0.4
-145.00	865.00	--	1.2 ± 0.3	1.9 ± 0.4
-145.00	825.00	--	1.6 ± 0.3	2.8 ± 0.5
-155.00	965.00	10.2 ± 0.5	2.5 ± 0.4	0.7 ± 0.2
-145.00	965.00	--	1.4 ± 0.5	1.1 ± 0.4
-135.00	965.00	246.0 ± 7.8	20.8 ± 0.9	3.0 ± 0.8
-125.00	965.00	--	1.1 ± 0.2	1.2 ± 0.4
-115.00	965.00	121.4 ± 8.0	62.4 ± 1.7	4.6 ± 1.0
-156.00	955.00	--	3.4 ± 0.4	3.5 ± 0.6
-135.00	955.00	--	0.7 ± 0.2	2.2 ± 0.5
-125.00	955.00	--	1.3 ± 0.4	1.5 ± 0.7
-115.00	955.00	--	4.1 ± 0.4	1.2 ± 0.4
-166.00	945.00	--	4.8 ± 0.6	1.9 ± 0.5
-135.00	945.00	9.0 ± 3.3	3.8 ± 0.4	1.5 ± 0.4
-125.00	945.00	--	1.2 ± 0.2	2.4 ± 0.5
-175.00	935.00	--	2.9 ± 0.4	2.0 ± 0.5
-145.00	935.00	--	10.9 ± 0.7	--
-135.00	935.00	23.7 ± 5.4	15.0 ± 0.8	--
-125.00	934.00	--	0.9 ± 0.3	1.1 ± 0.4
-185.00	925.00	--	1.9 ± 0.3	1.7 ± 0.6
-135.00	925.00	4.5 ± 2.2	1.3 ± 0.3	2.9 ± 0.6
-192.50	915.00	--	1.4 ± 0.4	2.4 ± 0.6
-155.00	915.00	14.5 ± 2.8	8.9 ± 0.6	--
-214.00	905.00	--	1.0 ± 0.2	1.1 ± 0.5
-205.00	905.00	--	1.1 ± 0.2	1.7 ± 0.4
-165.00	905.00	22.3 ± 4.5	8.9 ± 0.7	1.7 ± 0.4
-155.00	905.00	132.7 ± 9.4	158.0 ± 2.6	--
-145.00	905.00	7.0 ± 4.6	5.6 ± 0.6	0.8 ± 0.5

TABLE 8-3
(continued)

Page 4 of 5

Coordinates		Concentration (pCi/g +/- 2 sigma)		
E,W	N,S	Uranium-238	Radium-226	Thorium-232
-135.00	905.00	--	1.8 ± 0.2	1.8 ± 0.4
-125.00	905.00	2.4 ± 0.5	12.8 ± 0.9	2.2 ± 0.7
-215.00	895.00	--	1.2 ± 0.2	3.0 ± 0.6
-205.00	895.00	289.3 ± 9.0	2.7 ± 0.4	--
-195.00	895.00	20.2 ± 3.8	27.4 ± 1.1	4.8 ± 0.9
-175.00	895.00	13.3 ± 5.7	12.3 ± 0.8	--
-165.00	895.00	128.9 ± 12.1	98.6 ± 2.1	--
-165.00	896.00	--	1.2 ± 0.3	2.3 ± 0.4
-155.00	895.00	--	55.7 ± 1.5	--
-145.00	895.00	8.2 ± 4.3	7.0 ± 0.6	3.3 ± 0.6
-135.00	895.00	5.2 ± 2.5	3.0 ± 0.4	2.1 ± 0.4
-225.00	885.00	13.9 ± 5.1	13.2 ± 0.7	1.6 ± 0.8
-215.00	885.00	52.4 ± 8.2	7.5 ± 0.6	1.5 ± 0.4
-195.00	885.00	6.7 ± 3.7	7.5 ± 0.6	--
-185.00	885.00	58.2 ± 5.1	8.2 ± 0.7	2.2 ± 0.7
-165.00	885.00	469.8 ± 15.5	293.3 ± 4.0	--
-155.00	885.00	--	1.9 ± 0.3	2.1 ± 0.6
-235.00	875.00	10.3 ± 4.0	7.6 ± 0.6	1.0 ± 0.1
-225.00	875.00	--	2.2 ± 0.3	2.4 ± 0.5
-215.00	875.00	--	1.1 ± 0.3	1.9 ± 0.4
-205.00	875.00	--	1.6 ± 0.3	2.5 ± 0.5
-195.00	875.00	--	0.6 ± 0.3	2.3 ± 0.5
-185.00	875.00	93.9 ± 6.4	35.6 ± 1.4	--
-175.00	875.00	30.0 ± 4.9	8.1 ± 0.7	3.0 ± 0.6
-165.00	875.00	7.9 ± 3.8	5.6 ± 0.5	--
-155.00	875.00	--	0.9 ± 0.2	0.9 ± 0.2
-245.00	865.00	--	48.6 ± 1.9	--
-225.00	865.00	31.5 ± 5.0	13.6 ± 0.7	3.5 ± 0.7
-215.00	865.00	--	1.4 ± 0.2	1.4 ± 0.5
-205.00	865.00	--	1.1 ± 0.4	2.3 ± 0.6
-195.00	865.00	6.2 ± 2.5	2.1 ± 0.3	2.6 ± 0.6
-185.00	865.00	8.5 ± 3.1	2.9 ± 0.4	--
-255.00	855.00	8.3 ± 4.5	2.3 ± 0.6	3.0 ± 1.2
-245.00	855.00	27.7 ± 3.7	19.0 ± 0.8	1.3 ± 0.4
-225.00	855.00	32.0 ± 4.4	1.3 ± 0.2	1.9 ± 0.4
-215.00	855.00	--	1.9 ± 0.3	2.5 ± 0.4
-185.00	855.00	22.5 ± 4.0	7.1 ± 0.6	2.4 ± 0.5
-245.00	845.00	9.7 ± 5.4	2.2 ± 0.3	2.5 ± 0.4
-235.00	845.00	--	1.1 ± 0.3	1.6 ± 0.5
-225.00	845.00	6.7 ± 3.1	4.2 ± 0.5	2.6 ± 0.5
-215.00	845.00	78.0 ± 7.8	32.4 ± 1.2	1.4 ± 1.2
-205.00	845.00	5.4 ± 2.4	1.6 ± 0.3	2.1 ± 0.7
-195.00	845.00	31.3 ± 4.4	2.8 ± 0.4	1.3 ± 0.4
-185.00	845.00	40.2 ± 4.8	34.4 ± 1.3	3.7 ± 1.2
-225.00	835.00	--	6.9 ± 0.5	1.5 ± 0.5
-215.00	835.00	--	2.0 ± 0.3	--

TABLE 8-3
(continued)

Page 5 of 5

Coordinates		Concentration (pCi/g +/- 2 sigma)		
E,W	N,S	Uranium-238	Radium-226	Thorium-232
-205.00	835.00	6.6 ± 3.1	3.3 ± 0.4	2.8 ± 0.6
-195.00	835.00	4.1 ± 1.8	1.3 ± 0.3	2.2 ± 0.5
-225.00	825.00	31.6 ± 7.5	19.3 ± 0.9	2.3 ± 0.7
-215.00	825.00	21.5 ± 2.6	5.0 ± 0.5	2.2 ± 0.4
-235.00	865.00	116.4 ± 11.9	108.3 ± 2.3	--
-175.00	865.00	3.9 ± 2.6	1.1 ± 0.2	1.8 ± 0.4
-145.00	965.00	384.1 ± 12.7	151.7 ± 2.4	--
-135.00	968.00	7.5 ± 2.9	4.0 ± 0.5	1.5 ± 0.6
-115.00	968.00	--	1.2 ± 0.2	1.5 ± 0.5
-100.00	968.00	--	0.4 ± 0.2	1.5 ± 0.3
-85.00	968.00	28.8 ± 7.8	30.7 ± 1.1	5.0 ± 1.0
-70.00	968.00	63.2 ± 18.7	38.6 ± 1.6	13.5 ± 1.5
-160.00	960.00	143.4 ± 9.2	100.4 ± 1.9	--
-145.00	960.00	--	4.3 ± 0.4	1.4 ± 0.4
-130.00	960.00	--	1.2 ± 0.3	1.0 ± 0.4
-115.00	960.00	29.1 ± 9.6	20.1 ± 1.0	3.7 ± 0.8
-100.00	960.00	83.4 ± 8.4	69.8 ± 2.0	7.1 ± 1.6
-85.00	960.00	70.4 ± 12.9	35.8 ± 1.6	3.6 ± 0.9
-70.00	963.00	54.2 ± 7.0	18.1 ± 0.8	1.7 ± 0.6
-115.00	945.00	29.2 ± 7.6	31.0 ± 1.2	2.5 ± 0.8
-130.00	945.00	--	1.0 ± 0.2	2.7 ± 0.6
-115.00	945.00	--	1.3 ± 0.3	1.7 ± 0.3
-100.00	942.00	173.7 ± 10.2	126.3 ± 2.4	--
-180.00	940.00	4.0 ± 2.4	2.4 ± 0.4	1.7 ± 0.4

TABLE 8-4

GAMMA SPECTROMETRY ANALYSIS OF MSP SOIL SAMPLES FROM BORINGS

Page 1 of 2

Coordinates		Depth (cm)	Concentration (pCi/g +/- 2 sigma)		
E,W	N,S		Uranium-238	Radium-226	Thorium-232
-180.00	940.00	33.0	--	4.4 ± 0.5	1.5 ± 0.6
-180.00	940.00	43.2	--	0.9 ± 0.2	2.2 ± 0.8
-180.00	940.00	53.3	31.6 ± 4.7	47.7 ± 1.4	4.2 ± 1.1
-180.00	940.00	76.2	--	0.8 ± 0.3	1.5 ± 0.4
-180.00	940.00	86.4	1.2 ± 0.2	2.6 ± 0.4	2.1 ± 0.5
-180.00	940.00	96.5	--	3.6 ± 0.4	3.1 ± 0.5
-180.00	940.00	106.7	--	1.6 ± 0.3	2.5 ± 0.4
-180.00	940.00	116.8	--	1.1 ± 0.2	2.3 ± 0.8
-180.00	940.00	147.3	9.0 ± 2.6	1.7 ± 0.3	2.0 ± 0.4
-170.00	950.00	38.1	6.5 ± 2.3	1.2 ± 0.2	1.7 ± 0.4
-170.00	950.00	48.3	--	0.8 ± 0.2	--
-170.00	950.00	58.4	--	0.9 ± 0.4	--
-170.00	950.00	68.6	--	0.9 ± 0.2	1.4 ± 0.3
-170.00	950.00	78.7	--	0.8 ± 0.3	1.5 ± 0.4
-170.00	950.00	88.9	--	0.8 ± 0.2	1.3 ± 0.4
-170.00	950.00	119.4	--	1.4 ± 0.3	2.2 ± 0.8
-170.00	950.00	149.9	--	0.9 ± 0.7	2.7 ± 0.7
-137.50	960.00	35.6	--	1.2 ± 0.3	--
-137.50	960.00	48.3	--	1.3 ± 0.2	1.5 ± 0.4
-137.50	960.00	58.4	--	1.0 ± 0.2	1.2 ± 0.3
-137.50	960.00	68.6	--	1.2 ± 0.3	1.1 ± 0.5
-137.50	960.00	78.7	--	1.0 ± 0.2	1.0 ± 0.7
-137.50	960.00	86.4	2.8 ± 1.7	1.0 ± 0.2	1.6 ± 0.4
-137.50	960.00	111.8	3.8 ± 2.3	1.3 ± 0.4	1.8 ± 0.6
-92.50	960.00	10.2	59.7 ± 10.7	32.0 ± 1.5	3.1 ± 0.9
-92.50	960.00	20.3	40.5 ± 4.9	36.9 ± 1.3	2.2 ± 1.0
-92.50	960.00	30.5	15.0 ± 4.0	6.8 ± 0.6	1.5 ± 0.8
-92.50	960.00	43.2	--	4.7 ± 0.7	3.4 ± 1.0
-92.50	960.00	73.7	11.3 ± 4.5	3.7 ± 0.8	3.0 ± 1.7
-92.50	960.00	104.1	--	1.4 ± 0.4	2.8 ± 0.8
-92.50	960.00	147.3	6.5 ± 3.4	1.1 ± 0.4	3.0 ± 0.7
-220.00	832.50	30.5	--	79.2 ± 1.6	1.5 ± 1.0
-220.00	832.50	91.4	20.9 ± 6.5	19.5 ± 1.1	4.1 ± 0.9
-220.00	832.50	121.9	--	2.6 ± 0.4	1.6 ± 0.5
-220.00	832.50	152.4	--	1.3 ± 0.4	2.0 ± 0.5
-235.00	710.00	40.6	21.4 ± 5.9	21.5 ± 1.0	3.0 ± 0.9
-235.00	710.00	50.8	--	1.7 ± 0.3	2.0 ± 0.6
-235.00	710.00	61.0	--	1.1 ± 0.2	1.8 ± 0.4
-235.00	710.00	71.1	--	1.2 ± 0.3	2.0 ± 0.4
-235.00	710.00	81.3	--	1.1 ± 0.2	3.3 ± 0.6
-235.00	710.00	104.1	--	1.0 ± 0.8	2.1 ± 0.7
-235.00	710.00	127.0	--	1.4 ± 0.4	2.3 ± 1.0
-212.50	732.50	76.2	16.5 ± 5.4	6.9 ± 0.6	0.8 ± 0.7

TABLE 8-4
(continued)

Page 2 of 2

Coordinates		Depth (cm)	Concentration (pCi/g +/- 2 sigma)		
E,W	N,S		Uranium-238	Radium-226	Thorium-232
-212.50	732.50	86.4	11.8 ± 3.4	1.9 ± 0.3	2.5 ± 0.5
-212.50	732.50	111.8	8.1 ± 5.5	2.1 ± 0.5	--
-204.00	900.00	33.0	--	1.6 ± 0.3	1.8 ± 0.4
-204.00	900.00	43.2	--	1.6 ± 0.4	3.2 ± 0.7
-204.00	900.00	68.6	--	4.5 ± 0.6	--
-204.00	900.00	99.1	37.9 ± 9.2	28.9 ± 1.7	--
-204.00	900.00	129.5	--	2.5 ± 0.4	3.4 ± 0.8
-204.00	900.00	160.0	6.4 ± 3.0	1.1 ± 0.8	--
-234.00	870.00	73.7	29.2 ± 4.8	24.3 ± 1.1	1.4 ± 0.6
-234.00	870.00	83.8	15.8 ± 2.6	1.2 ± 0.3	1.7 ± 0.5
-234.00	870.00	94.0	3.1 ± 1.6	1.0 ± 0.3	1.3 ± 0.3
-234.00	870.00	104.1	--	0.8 ± 0.2	1.2 ± 0.4
-234.00	870.00	114.3	--	1.2 ± 0.2	1.2 ± 0.5
-234.00	870.00	134.6	--	1.7 ± 0.4	3.6 ± 0.9
-234.00	855.00	33.0	26.8 ± 5.2	8.8 ± 0.7	1.8 ± 0.5
-234.00	855.00	43.2	9.8 ± 4.1	7.7 ± 0.6	2.4 ± 1.2
-234.00	855.00	53.3	58.8 ± 4.5	27.9 ± 1.0	1.6 ± 0.8
-234.00	855.00	83.8	29.2 ± 9.8	54.6 ± 1.7	2.7 ± 1.1
-234.00	855.00	144.8	25.7 ± 4.8	8.5 ± 0.7	--
-234.00	855.00	152.4	11.8 ± 4.7	2.0 ± 0.6	3.8 ± 1.2
-190.00	856.00	99.1	397.7 ± 25.3	208.4 ± 5.5	--
-190.00	856.00	114.3	89.1 ± 19.9	67.4 ± 3.5	--
-190.00	856.00	127.0	--	2.9 ± 0.6	2.5 ± 0.8

concentration in pCi/g. Because MSP is covered with varying thicknesses of asphalt, a correlation factor could not be determined. However, high gamma readings generally related to elevated concentrations of radionuclides in the soil. Results were determined for uranium-238, radium-226, and thorium-232. The maximum concentration for uranium-238 was 961 pCi/g. The maximum radium-226 concentration was 736 pCi/g. The maximum thorium-232 concentration was 19.3 pCi/g.

The major contaminants in soil samples taken from borings were uranium-238 and radium-226. The maximum uranium-238 concentration was 398 pCi/g; the maximum radium-226 concentration was 208 pCi/g. Correlations between concentrations of radionuclides in soil samples and borehole gamma count rates were used to determine the depth of contamination.

8.3.2 Process Building

The concrete dock and roof along the east side of the process building were monitored in the same manner as the floors. The inside surface of the roof parapet and its ceramic top were monitored at 2.5-m (8.2-ft) intervals. Results of the radiological survey conducted in the building are summarized in Table 8-5.

In the process building, approximately 90 percent of the measurements taken on the interior and exterior surfaces indicated elevated levels of alpha contamination. The maximum reading observed was 40,256 dpm/100 cm². The maximum beta-gamma dose rate observed was 1.43 mrad/h.

The maximum radon flux measurement was 168 pCi/(m²·s); for time-integrated radon, the measurement was 3.54 pCi/L.

Subsurface soil samples from boreholes drilled through the first floor indicated contaminated soils at a depth of 1.4 m (4.5 ft). This depth corresponds to the original grade prior to installation of a concrete floor in the building.

TABLE 8-5
SUMMARY OF PREREMEDIAL ACTION BUILDING MEASUREMENT RESULTS
FORMER MSP

Page 1 of 4

Measurement Locations	Measurement Type	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed	Units
<u>PROCESS BUILDING</u>					
<u>Interior</u>					
Floor	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	1,755 1,755	0.01 - 0.19 58 - 2,375	0.65 7,089	mrad/h dpm/100 cm ²
Walls	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	1,610 1,610	0.01 - 0.15 34 - 2,422	0.28 3,842	mrad/h dpm/100 cm ²
Window Ledges ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	116 116	0.01 - 0.48 68 - 2,108	0.48 2,108	mrad/h dpm/100 cm ²
Floor/Wall Intersections ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	179 179	0.01 - 1.43 34 - 4,335	1.43 4,335	mrad/h dpm/100 cm ²
Ceiling ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	81 81	0.01 - 0.26 0 - 2,635	0.26 2,635	mrad/h dpm/100 cm ²
Steel Beams ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	69 69	0.01 - 0.43 51 - 40,256	0.43 40,256	mrad/h dpm/100 cm ²
Wood Beams ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	71 71	0.01 - 0.64 17 - 13,532	0.64 13,532	mrad/h dpm/100 cm ²
Miscellaneous Items ^a	Beta-Gamma Dose Rate Direct Alpha Activity on Surfaces	20 20	0.01 - 0.08 51 - 5049	0.08 5,049	mrad/h dpm/100 cm ²
Floor and Walls ^a	Radon Flux	25	0.42 - 168.0	168.0	pCi/m ² /s
Room Air	Air Particulate Activity Time-Integrated Radon	20 9	Below MDA ^b - 0.05 0.40 - 3.54	0.05 3.54	pCi/m ³ pCi/L
<u>Exterior</u>					
Walls	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	2,445 2,445	0.01 - 0.40 51 - 18,887	0.49 18,887	mrad/h dpm/100 cm ²
Roof	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	1,755 1,755	0.01 - 0.84 41 - 527	4.17 1,122	mrad/h dpm/100 cm ²
Window Ledges ^a	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	88 88	0.01 - 0.26 17 - 5,916	0.26 5,916	mrad/h dpm/100 cm ²
Dock	Beta-Gamma Dose Rates Direct Alpha Activity on Surfaces	50 50	0.02 - 0.04 122 - 629	0.09 1,416	mrad/h dpm/100 cm ²

TABLE 8-5
(continued)

Page 2 of 4

Measurement Location	Measurement Type	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed	Units
<u>BOILER HOUSE</u>					
<u>Interior</u>					
Floors	Beta-Gamma Dose Rates	120	0.01 - 0.02	0.03	mrads/h
	Direct Alpha Activity on Surfaces	120	78 - 279	476	dpm/100 cm ²
Walls	Beta-Gamma Dose Rates	170	0.01 - 0.05	0.08	mrads/h
	Direct Alpha Activity on Surfaces	170	54 - 364	612	dpm/100 cm ²
Floor/Wall Intersection ^a	Beta-Gamma Dose Rates	34	0.01 - 0.05	0.05	mrads/h
	Direct Alpha Activity on Surfaces	34	34 - 442	442	dpm/100 cm ²
Window Ledges ^a	Beta-Gamma Dose Rates	8	0.02 - 0.17	0.17	mrads/h
	Direct Alpha Activity on Surfaces	8	17 - 799	799	dpm/100 cm ²
Miscellaneous Items ^a	Beta-Gamma Dose Rates	10	0.01 - 0.17	0.17	mrads/h
	Direct Alpha Activity on Surfaces	10	34 - 5,049	5049	dpm/100 cm ²
Floors and Walls ^a	Radon Flux Measurements	2	0.60 - 8.93	8.93	pCi/m ² /s
Room Air ^a	Air Particulate Activity	10	Below MDA - 0.05	0.05	pCi/m ³
	Time-Integrated Radon	1	0.53	0.53	pCi/L
<u>Exterior</u>					
Walls	Beta-Gamma Dose Rates	245	0.01 - 0.07	0.15	mrads/h
	Direct Alpha Activity on Surfaces	245	146 - 4,482	6494	dpm/100 cm ²
Roof	Beta-Gamma Dose Rates	240	0.01 - 0.02	0.03	mrads/h
	Direct Alpha Activity on Surfaces	240	51 - 153	272	dpm/100 cm ²

TABLE 8-5
(continued)

Page 3 or 4

Measurement Locations	Measurement Type	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed	Units
<u>ADMINISTRATION BUILDING</u>					
<u>Interior</u>					
Floors	Beta-Gamma Dose Rate	600	0.01 - 0.07	0.09	mrads/h
	Direct Alpha Activity on Surfaces	600	0 - 1,317	3,536	dpm/100 cm ²
Walls	Beta-Gamma Dose Rate	18	0.01 - 0.02	0.02	mrads/h
	Direct Alpha Activity on Surfaces	18	17 - 119	119	dpm/100 cm ²
Floor/Wall Intersection ^a	Beta-Gamma Dose Rate	106	0.01 - 0.06	0.06	mrads/h
	Direct Alpha Activity on Surfaces	106	34 - 1,360	1,360	dpm/100 cm ²
Window Ledges ^a	Beta-Gamma Dose Rate	26	0.01 - 0.02	0.02	mrads/h
	Direct Alpha Activity on Surfaces	26	34 - 204	204	dpm/100 cm ²
Drains ^a	Beta-Gamma Dose Rate	8	0.01 - 0.13	0.13	mrads/h
	Direct Alpha Activity on Surfaces	8	34 - 1,071	1,071	dpm/100 cm ²
Floors and Walls ^a	Radon Flux	2	0.11 - 0.15	0.15	pCi/m ² /s
Room Air	Air Particulate Activity	17	Below MDA - 0.09	0.09	pCi/m ³
	Time-Integrated Radon	2	Nondetectable		pCi/l
<u>Exterior</u>					
Window Ledges ^a	Beta-Gamma Dose Rate	25	0.01 - 0.02	0.02	mrads/h
	Direct Alpha Activity on Surfaces	25	17 - 68	68	dpm/100 cm ²
Roof	Beta-Gamma Dose Rate	600	0.04 - 0.07	0.08	mrads/h

TABLE 8-5
(continued)

Page 4 of 4

Measurement Location	Measurement Type	No. of Readings Taken	Grid Block Average Range	Maximum Reading Observed	Units
<u>GARAGE</u>					
<u>Interior</u>					
Floor	Beta-Gamma Dose Rate	375	0.01 - 0.04	0.05	mrads/h
	Direct Alpha Activity on Surfaces	375	19 - 253	680	dpm/100 cm ²
Floor/Wall Intersection ^a	Beta-Gamma Dose Rate	40	0.01 - 0.11	0.11	mrads/h
	Direct Alpha Activity on Surface	40	51 - 527	527	dpm/100 cm ²
Miscellaneous Items ^a	Beta-Gamma Dose Rate	20	0.01 - 0.13	0.13	mrads/h
	Direct Alpha Activity on Surfaces	20	34 - 5015	5015	dpm/100 cm ²
Room Air ^a	Air Particulate Activity	17	Below MDA - 0.10	0.10	pCi/m ³
	Time-Integrated Radon	2	Nondetectable		pCi/l
<u>Exterior</u>					
Roof	Beta-Gamma Dose Rate	195	0.01 - 0.02	0.02	mrads/h
	Direct Alpha Activity on Surfaces	195	68 - 144	204	dpm/100 cm ²

^aOnly one measurement was read per grid block.

^bMDA—Minimum Detectable Activity.

8.3.3 Boiler House

In the boiler house, readings from interior floors, walls, and the floor-wall intersections indicated elevated levels of alpha contamination in some areas. The maximum interior alpha surface measurement observed was 799 dpm/100 cm². Results of the radiological survey conducted in the building are summarized in Table 8-5.

Miscellaneous measurements taken on inside heaters, pipes, and beams showed some alpha contamination with a maximum reading of 5,049 dpm/100 cm².

The maximum radon flux measurement was 8.93 pCi/(m²·s); for time-integrated radon, the measurement was 0.53 pCi/L.

Three exterior walls were surveyed--the west exterior wall was inaccessible. The maximum alpha surface measurement was 6,494 dpm/100 cm².

The roof showed scattered contamination; the maximum measurement for alpha surface contamination was 272 dpm/100 cm².

8.3.4 Administration Building

In the administration building, interior measurements were taken on the floor, at the floor-wall intersections, on the drains, and at random locations on the walls. The maximum alpha surface measurement observed was 3,536 dpm/100 cm². Results of the radiological survey conducted in the building are summarized in Table 8-5.

The maximum radon flux measurement was 0.15 pCi/(m²·s); time-integrated radon was nondetectable.

A few areas of elevated alpha readings were found and will require decontamination.

8.3.5 Garage

Interior measurements were taken on the floors, at the floor-wall intersections, and on miscellaneous items inside the garage. The maximum alpha level, 5,015 dpm/100 cm², was observed on a heater. Results of the radiological survey conducted in the building are summarized in Table 8-5.

Radon flux data were lost during processing, and time-integrated radon was nondetectable.

Exterior measurements were taken on the garage roof. Elevated alpha readings were observed in two areas. The maximum measurement was 204 dpm/100 cm².

8.4 MISCELLANEOUS ENVIRONMENTAL MONITORING

In 1983, samples were taken from several of the borings. These samples were analyzed for uranium-238 and radium-226 at the Eberline Instrument Corporation in Albuquerque, New Mexico. The uranium-238 concentration ranged from 1.5 to 1,288 pCi/L; the radium-226 concentration ranged from <0.1 to 71.0 pCi/L. Water sample results are listed in Table 8-6.

Gamma exposure rates were measured using a pressurized ionization chamber (PIC) at 1 m (3.3 ft) above the ground. The exposure rates ranged from 16 to 371 µR/h. As noted earlier, the natural background gamma exposure rate was measured as 6.1 µR/h. Results are listed in Table 8-7.

A surface-activity radiation survey of the mosquito control ditch was conducted in the first quarter of 1986 (Figure 8-3). Samples were taken at the plant outfall, at the confluence, and downstream of the confluence. The concentration of uranium-238 in the sediments ranged from 0.8 to 38.7 pCi/g. The concentrations of radium-226 in the sediments ranged from 0.4 to 42.0 pCi/g. A resurvey was conducted of the locations in July 1987, which

TABLE 8-6
RADIOCHEMICAL ANALYSIS OF MSP SUBSURFACE WATER SAMPLES

Coordinates		Concentration (pCi/L +/- 2 sigma)	
E, W	N, S	Uranium-238	Radium-226
-175	795	33.0	0.2 ± 0.1
-190	930	1288.0	71.0 ± 21.0
-108	915	1.8	0.1
-130	900	4.5	0.3 ± 0.1
-145	855	1.5	0.3 ± 0.1
-175	870	68.0	0.4 ± 0.1
-185	945	33.0	1.4 ± 0.4
-192.5	780	12.7	0.2 ± 0.1
200	720	86.3	0.6 ± 0.2
-207	795	3.0	0.2 ± 0.1
-235	695	6.7	0.1 ± 0.1
-235	810	1.5	0.3 ± 0.1
-235	825	5.8	0.8 ± 0.2
-235	855	209.0	26.0 ± 8.0
-235	870	7.9	1.5 ± 0.5
-236	705	33.0	0.9 ± 0.3
-247.5	870	34.8	2.7 ± 0.8
-250	697.5	11.0	0.2 ± 0.1
-250	825	1.5	0.1
-250	840	2.4	0.1
-265.5	855	2.1	0.2 ± 0.1
-340	795	17.9	0.9 ± 0.3

TABLE 8-7
PIC READINGS
AT SELECTED MSP LOCATIONS

Page 1 of 4

Coordinates		PIC ^a (μ R/h)
E,W	N,S	
-350.00	790.00	16.20
-340.00	780.00	26.80
-340.00	800.00	17.00
-330.00	770.00	17.60
-330.00	800.00	19.60
-330.00	810.00	21.80
-320.00	760.00	17.80
-320.00	810.00	25.60
-320.00	820.00	23.80
-310.00	750.00	16.80
-310.00	830.00	55.40
-300.00	840.00	59.80
-290.00	740.00	24.40
-290.00	850.00	37.80
-290.00	860.00	17.20
-285.00	735.00	41.00
-280.00	860.00	48.60
-275.00	725.00	57.40
-275.00	735.00	37.60
-270.00	850.00	24.80
-265.00	715.00	53.00
-265.00	725.00	30.60
-260.00	840.00	21.20
-260.00	850.00	24.80
-255.00	705.00	35.20
-255.00	715.00	36.40
-250.00	730.00	33.20
-250.00	830.00	31.00
-250.00	840.00	27.00
-250.00	860.00	33.00
-245.00	695.00	19.20
-245.00	705.00	21.00
-245.00	715.00	21.60
-245.00	825.00	32.40
-240.00	700.00	17.20
-240.00	710.00	17.80
-240.00	720.00	22.00
-240.00	730.00	31.00
-240.00	820.00	33.80
-240.00	860.00	23.20
-240.00	870.00	33.60
-230.00	710.00	19.60
-230.00	720.00	57.60
-230.00	730.00	26.00

TABLE 8-7
(continued)

Page 2 of 4

Coordinates		PIC ^a
E,W	N,S	(μ R/h)
-230.00	740.00	29.80
-230.00	810.00	34.20
-230.00	820.00	38.80
-230.00	840.00	22.60
-230.00	870.00	21.20
-230.00	880.00	60.40
-220.00	720.00	23.40
-220.00	730.00	63.60
-220.00	750.00	42.80
-220.00	800.00	28.20
-220.00	810.00	24.80
-220.00	840.00	19.60
-220.00	850.00	23.20
-220.00	880.00	27.60
-220.00	890.00	75.40
-210.00	730.00	29.40
-210.00	740.00	107.00
-210.00	750.00	92.80
-210.00	760.00	43.00
-210.00	790.00	41.40
-210.00	800.00	28.40
-210.00	820.00	17.60
-210.00	850.00	21.00
-210.00	860.00	18.80
-210.00	890.00	25.60
-210.00	910.00	55.80
-200.00	750.00	40.60
-200.00	760.00	121.80
-200.00	770.00	46.00
-200.00	780.00	25.40
-200.00	790.00	22.60
-200.00	820.00	78.00
-200.00	830.00	18.40
-200.00	860.00	53.00
-200.00	870.00	28.40
-200.00	890.00	22.20
-200.00	900.00	56.60
-200.00	910.00	49.20
-190.00	760.00	29.60
-190.00	770.00	72.80
-190.00	780.00	22.00
-190.00	800.00	40.80
-190.00	830.00	117.60
-190.00	840.00	23.80
-190.00	870.00	20.60
-190.00	890.00	49.20

TABLE 8-7
(continued)

Page 3 of 4

Coordinates		PIC ^a
E,W	N,S	(μ R/h)
-190.00	920.00	49.00
-190.00	930.00	306.60
-180.00	770.00	20.20
-180.00	780.00	41.00
-180.00	800.00	21.00
-180.00	810.00	36.20
-180.00	840.00	50.20
-180.00	850.00	23.00
-180.00	870.00	24.80
-180.00	880.00	23.40
-180.00	890.00	30.00
-180.00	930.00	263.00
-180.00	940.00	371.40
-170.00	810.00	24.40
-170.00	820.00	43.00
-170.00	850.00	55.20
-170.00	880.00	25.80
-170.00	890.00	25.60
-170.00	900.00	28.60
-170.00	940.00	111.60
-170.00	950.00	245.40
-160.00	800.00	53.40
-160.00	830.00	31.80
-160.00	850.00	37.20
-160.00	900.00	27.60
-160.00	910.00	21.80
-160.00	950.00	61.40
-160.00	960.00	281.40
-157.50	917.50	32.00
-150.00	830.00	25.60
-150.00	860.00	71.60
-150.00	880.00	53.80
-150.00	910.00	21.60
-150.00	920.00	24.00
-150.00	960.00	307.00
-150.00	970.00	41.60
-140.00	820.00	33.60
-140.00	870.00	80.80
-140.00	900.00	24.40
-140.00	910.00	22.00
-140.00	920.00	17.80
-140.00	930.00	240.00
-140.00	940.00	27.20
-140.00	960.00	83.40
-130.00	840.00	79.40
-130.00	880.00	45.00

TABLE 8-7
(continued)

Page 4 of 4

Coordinates		PICA ^a (μ R/h)
E,W	N,S	
-130.00	930.00	20.80
-130.00	940.00	27.00
-130.00	950.00	35.60
-130.00	960.00	30.40
-125.00	915.00	23.00
-125.00	925.00	28.00
-120.00	840.00	49.80
-120.00	860.00	55.80
-120.00	900.00	53.60
-120.00	940.00	27.20
-110.00	880.00	73.80
-110.00	900.00	137.00
-110.00	940.00	53.80
-110.00	950.00	64.80
-110.00	960.00	27.60
-100.00	900.00	28.00
-100.00	910.00	25.60
-100.00	920.00	25.60
-100.00	930.00	24.00
-100.00	940.00	39.60
-100.00	960.00	175.60
-90.00	945.00	70.80
-90.00	960.00	81.20
-80.00	945.00	41.00
-80.00	965.00	44.60
-70.00	945.00	27.60
-70.00	960.00	43.00
-70.00	965.00	39.00

^aAccuracy of the PIC is ± 5 percent of reading at 10 μ R/h.

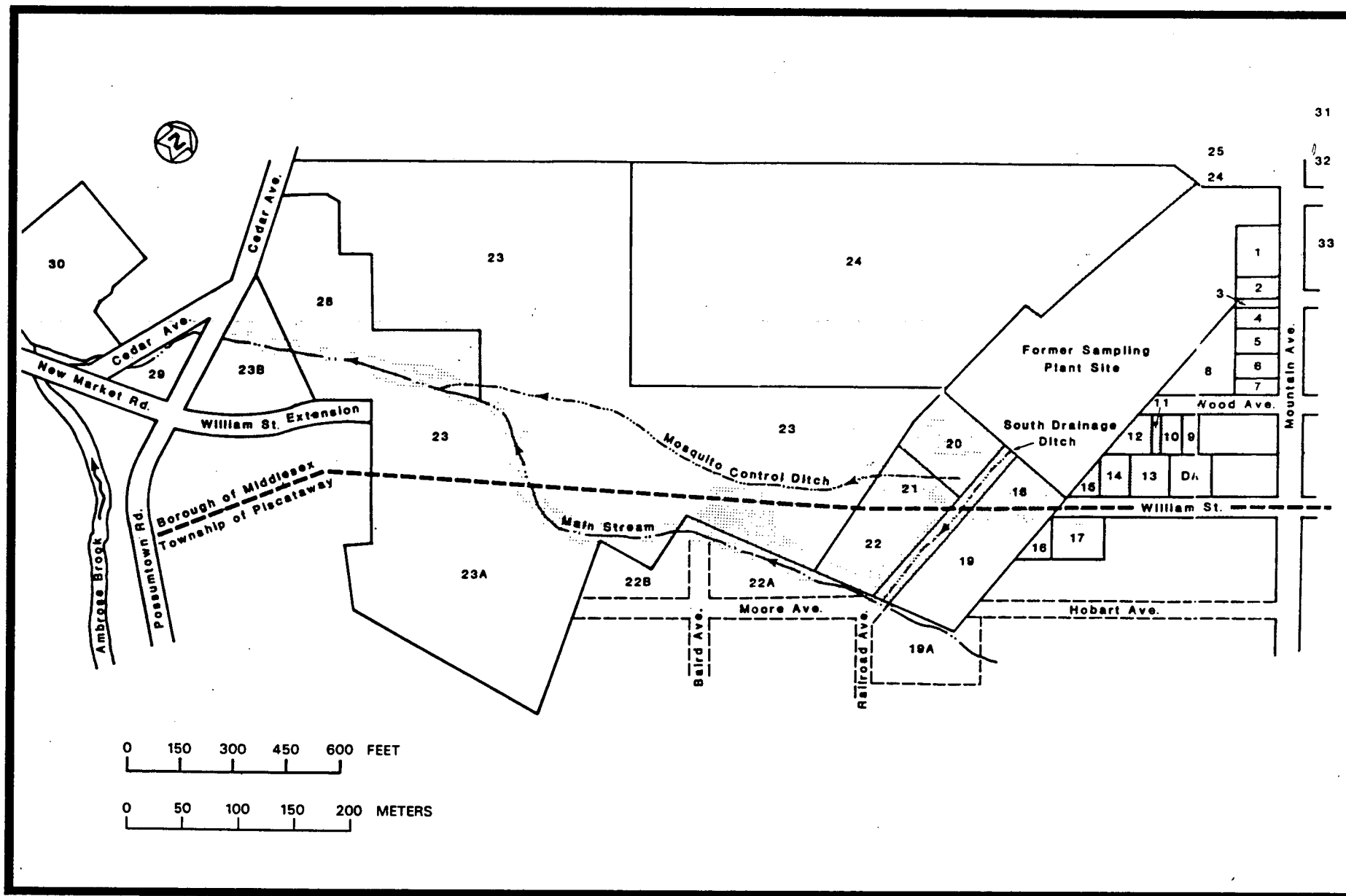


FIGURE 8-3 MAP OF THE MIDDLESEX PHASE II REMEDIAL ACTION PROPERTIES

indicated that the high results obtained in the first quarter of 1986 were not representative of the conditions of the locations sampled and that those data were anomalous.

The average annual radon-222 concentrations measured at the MSP boundaries using Terradex Monitors are included in Table 8-8. Station 6 is located on the external wall of the process building and, as a result, detects radon at higher levels than any of the perimeter stations. Station 6 has a potential bias because it is located on the east corner of the process building loading dock. Ores that are good radon generators are assumed to be present between the dock and the building. The 1987-1988 data from Station 6 and other stations are listed in Table 8-9. Sampling locations are shown in Figure 8-4.

In 1987, BNI surveyed the external gamma radiation level at the fenceline using a PIC 1 m (3.3 ft) above the ground. At the location of the maximum dose rate measured, 293 mrem/yr, a person could stay 8 hpd and still not exceed the annual allowable exposure of 100 mrem/yr. This scenario is considered the maximum potential risk to the general public from MSP.

TABLE 8-8
AVERAGE ANNUAL RADON-222 CONCENTRATIONS MEASURED
AT THE MSP SITE BOUNDARY
USING TERRADEX MONITORS, 1982-1987^a

Sampling Location ^b	Concentration (10 ⁻⁹ μ Ci/mL) ^{c,d}					
	1982	1983	1984	1985	1986	1987
2	0.66	0.43	0.3	0.3	0.6	1.0
4	0.61	0.68	0.9	0.5	1.0	0.8
5	0.47	0.39	0.4	0.2	0.8	0.8
7	0.39	0.31	0.5	0.3	1.0	0.9
8	0.31	0.28	0.5	0.3	1.0	0.6
9	0.25	0.39	0.4	0.2	1.0	0.8
10	0.33	0.24	0.2	0.2	1.0	0.7
11	0.49	0.46	0.4	0.2	1.1	1.0
12	0.44	0.50	0.4	0.3	0.9	0.4
13	0.17	0.34	0.5	0.3	0.9	1.4
14	0.33	0.56	0.4	0.4	1.2	0.9
15	0.40	0.54	0.5	0.3	0.3	0.3
16	0.30	0.33	0.4	0.2	0.7	0.8
17	0.40	0.33	0.6	0.2	0.7	0.7
18	0.40	0.43	0.5	0.2	0.8	1.0
19	0.37	0.33	0.3	0.2	1.1	1.3
20 ^e	0.42	0.34	0.6	0.3	1.1	1.5
22 ^e	-e-	-e-	-e-	0.4	0.9	1.6
<u>Background</u>						
29 ^f	--	--	--	0.8	2.0	1.2

^aSources of data for prior years are the annual site environmental reports for those years.

^bSampling locations for MSP are shown in Figure 8-4.

^c1 x 10⁻⁹ μ Ci/mL is equivalent to 1 pCi/L.

^dThe measurements are total radon concentrations; background has not been subtracted because of the variability in the distribution of radon.

^eIn 1985, Locations 20 and 22 at MSP were established as quality control stations for Locations 18 and 15, respectively; MML Location 5 was established as the quality control for Location 1.

^fLocated at 658 Leone St., Woodbridge, New Jersey. Established April 1985.

TABLE 8-9
RADON-222 CONCENTRATIONS MEASURED AT MSP
USING TERRADEX MONITORS, 1987-1988

Sampling Month	Sampling Station Concentration (pCi/L)				
	2	4	6	9	10
April 1987	1.1	1.1	6.6	0.2	0.3
July 1987	0.4	0.2	16.0	0.1	0.1
October 1987	1.4	0.4	3.3	0.5	0.6
January 1988	0.4	0.9	5.7	1.0	0.2
April 1988	0.4	0.5	2.5	0.9	0.7

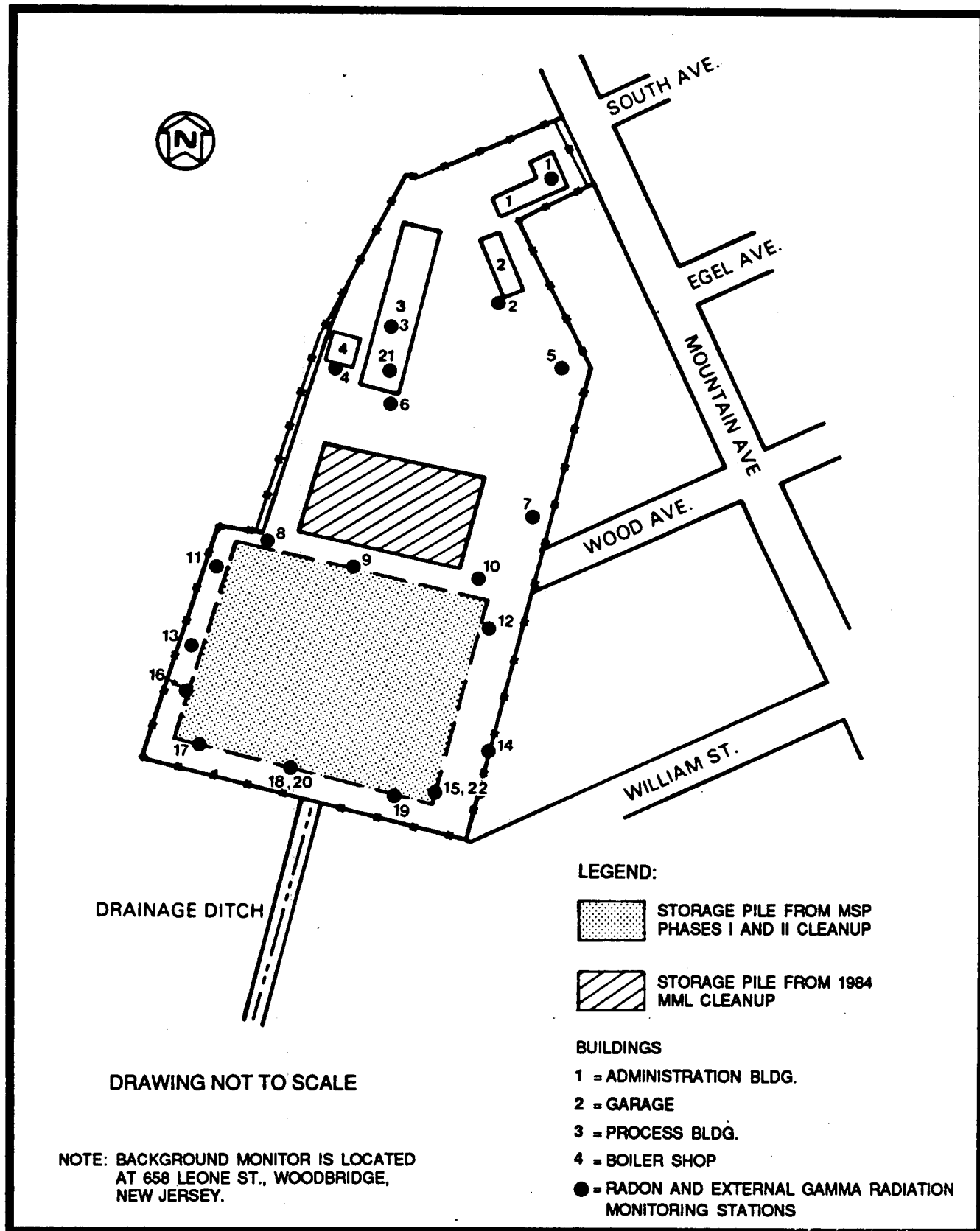


FIGURE 8-4 RADON (TERRADEX) AND EXTERNAL GAMMA RADIATION MONITORING LOCATIONS AT MSP

9.0 REMEDIAL ACTION

Remedial action at MML was conducted in two phases, in 1984 and 1986. Excavation of contaminated soil from the landfill began during the summer of 1984, and by November of that year, approximately $11,500 \text{ m}^3$ ($15,000 \text{ yd}^3$) had been removed to MSP. Excavation was halted in November 1984, and backfilling was completed. Excavation resumed in May 1986 and was completed in July of that year. The amount of material removed during 1986 was approximately equivalent to that excavated in 1984, bringing the total amount of contaminated material excavated from the landfill to $23,700 \text{ m}^3$ ($31,000 \text{ yd}^3$).

In 1981, remedial action included the decontamination of the Rectory and 432 William Street and restoration to the "as was" condition. Also included in the project was the erection of a temporary storage pile at MSP and containment of the pile with a moisture-impervious liner and cover.

DOE also decontaminated three additional properties; the Rectory Playground, Kays (312 Mountain Avenue), and Rosamilia (Wood Avenue) properties. The contaminated materials from these sites were included in the temporary MSP storage pile.

The volume of excavated material is presented in Table 9-1. The location of these properties is shown in Figure 3-6. The locations of storage piles at MSP are shown in Figure 9-1.

The compacted volume from the properties is equal to the Phase I volume in Table 3-1 after the site improvement volume is subtracted ($10,646 - 1,225 = 9,421 \text{ yd}^3$).

Detailed information regarding the remedial action performed in 1981 is included in Project Report of Phase I Remedial Action of Properties Associated with the Former Middlesex Sampling Plant Site (NLCO-DOO6EV).

TABLE 9-1
EXCAVATED VOLUME OF CONTAMINATED SOIL AT MSP

Area	Estimated Quantity ^a m ³ (yd ³)	Excavated Quantity m ³ (yd ³)	Compacted Quantity (Storage Pile) m ³ (yd ³)
Site (Resulting from Improvements Placed by Reid)	382 (500)	937 (1,225)	937 (1,225)
Rectory	1,376 (1,800)	4,544 ^b (5,943)	3,181 (4,160)
Williams Street	382 (500)	1,361 ^b (1,780)	953 (1,246)
Playground	153 (200)	170 ^b (223)	119 (156)
Rosamilia	2,294 (3,000)	4,070 ^b (5,323)	2,849 (3,726)
Kays	153 (200)	145 ^b (190)	102 (133)
TOTAL	4,740 (6,200)	11,227 (14,684)	8,141 ^c (10,646)

^aThe estimated quantities are based on the criterion set for MSP of 5 pCi/g of radium-226. Actual final levels of radium-226 were lower than 5 pCi/g as a result of sampling, instrument, and statistical considerations in applying the criterion, as described in Section 8.0.

^bThese quantities reflect the excavation quantities removed from the properties by the contractor.

^cThis figure represents the final compacted volume of the Phase I pile and has been verified by Ford, Bacon, Davis & Utah, Inc., field engineers.

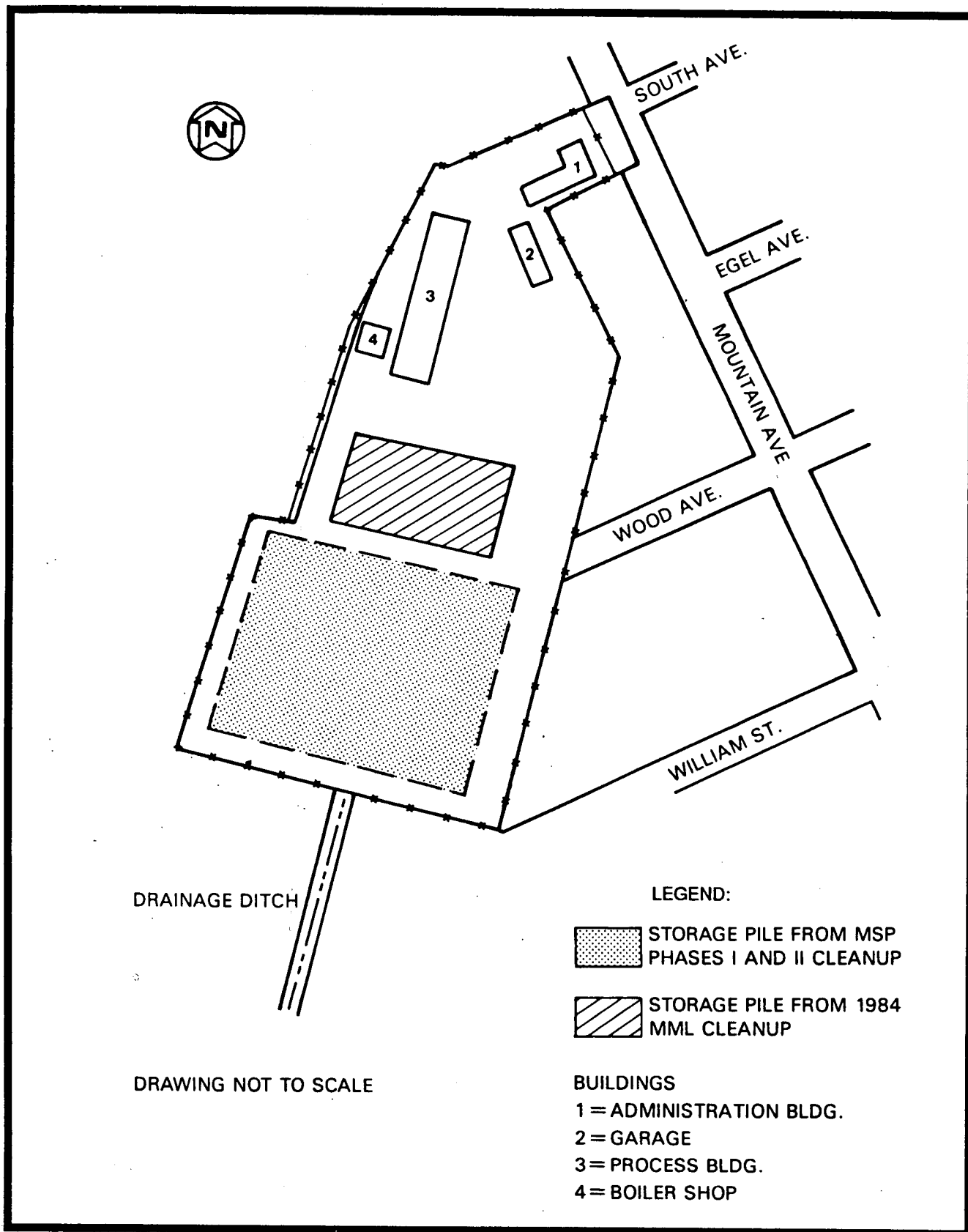


FIGURE 9-1 STORAGE PILES AT THE MSP SITE

The area where remedial action was performed in 1984 is shown in Figure 8-3. It includes residential, commercial, industrial, and unimproved lands. The buildings on these properties were not contaminated. Measurements showed that the contamination was primarily limited to the ground surface, indicating that wind and water were the primary modes of transport from the former MSP. Spread of radioactive material also resulted from physical transportation of soils during previous construction and demolition at the site.

Properties south of the site are in a wooded area that serve as a drainage basin for the vicinity. Most of the excavation occurred in this area. A drainage ditch flows past the south end of the site and then 180 m (600 ft) to Main Stream. Main Stream flows southwesterly past the site through a heavily wooded area for approximately 850 m (2,800 ft) before joining Ambrose Brook.

Contaminated soil was removed and transported from the adjacent and vicinity properties, including the above-mentioned wooded drainage area, and placed in the storage pile at the former MSP. A total of $19,700 \text{ m}^3$ ($25,700 \text{ yd}^3$) of contaminated soil was excavated. The soils were specifically obtained from the following locations:

1. Residential parcels along Mountain Avenue
2. Wooded property between Wood and William Street
3. Residence on Parcel 17 and William Street roadbed
4. South drainage area
5. Main Stream area

Contaminated soil was excavated to the extent necessary to remove soil with levels greater than 5 pCi/g of radium-226 above background.

Details regarding each vicinity property remediated during Phase II are included in Volume 2 of the Final Report on Phase II Remedial Action at the Former MSP and Associated Properties, Middlesex, New Jersey.

10.0 BIBLIOGRAPHY

1. U.S. Department of Energy, Draft Certification Docket for the Remedial Action Performed at Vicinity Properties in Middlesex, New Jersey, in 1984 and 1986, May 1987.
2. U.S. Department of Energy, Draft Preliminary Engineering Evaluation of Remedial Action Alternatives, Middlesex Municipal Landfill, Middlesex, New Jersey, September 1982.
3. U.S. Department of Energy, Final Report on Phase II Remedial Action at the Former Middlesex Sampling Plant and Associated Properties Middlesex, New Jersey, DOE/OR/20722-27 (Vol. 2), April 1985.
4. U.S. Department of Energy, Final Report on Phase II Remedial Action at the Former Middlesex Sampling Plant and Associated Properties, Middlesex, New Jersey, DOE/OR/20722-27 (Vol. 1), April 1985.
5. U.S. Department of Energy, Formerly Utilized MED/AEC Sites Remedial Action Program, Environmental Analysis of the Middlesex Municipal Landfill Site, Middlesex, New Jersey, FBDU 230-009, July 1979.
6. U.S. Department of Energy, Formerly Utilized MED/AEC Sites Remedial Action Program Environmental Assessment of the Properties Adjacent to and Nearby the Former Middlesex Sampling Plant, Middlesex, New Jersey, DOE/EA-0128, October 1980.
7. U.S. Department of Energy, Middlesex Sampling Plant and Middlesex Municipal Landfill Annual Site Environmental Report, Middlesex, New Jersey, Calendar Year 1985, DOE/OR/20722-97, August 1986.

8. U.S. Department of Energy, Project Report of Phase I Remedial Action of Properties Associated with the Former Middlesex Sampling Plant Site, Middlesex, New Jersey, NLCO-DOO6EV, April 1982.
9. Middlesex County Planning Board, Policies and Practices for Managing Middlesex County's Groundwater Resources, Middlesex, New Jersey, January 1979.
10. National Lead of Ohio, Inc., Environmental Assessment of the Properties Adjacent to and Nearby the Former Middlesex Sampling Plant, Middlesex, New Jersey, UC-342, October 1980.
11. Oak Ridge National Laboratory, Hydrology of the Former Middlesex Sampling Plant Site, Middlesex, New Jersey - Final Report, October 1980.
12. Oak Ridge National Laboratory, Radiological Surveys of Properties in the Middlesex, New Jersey Area, DOE/EV-0005/1 (Supplement), ORNL-5680, March 1981.
13. Oak Ridge National Laboratory: Radon and Radon Daughter Measurements at and Near the Former Middlesex Sampling Plant, Middlesex, New Jersey, ORNL-5489, March 1980.
14. Department of Energy, Radiological Survey Report for the Former Middlesex Sampling Plant, Middlesex, New Jersey, DOE/OR/20722-20, March 1985.